THE

JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

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GAS PURIFICATION
BY
OXIDE OF IRON.

COOKE BROS.,
CENTRAL DEPÔTS:
CO. DONEGAL, IRELAND;
LONDON DEPÔT:
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OFFICES:
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Resists Sulphuretted Hydrogen. Does not Blister, Crack, or Flake off. Has very large surfacing powers.
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BROOKFIELD GAS APPARATUS WORKS,
103, ICKNIELD STREET EAST, BIRMINGHAM.
CONTRACTOR FOR
LAYING MAINS
FOR
Gas, Water, & Sanitary Purposes,
AND MANUFACTURER OF
WOOD GRIDS
FOR
SCRUBBERS AND PURIFIERS.

COWEN'S PATENT FIRE-CLAY RETORTS.
JOSEPH COWEN and CO.,
BLAYDON BURN, BLAYDON-ON-TYNE,
Were the only parties to whom a Prize Medal was awarded at the Great Exhibition of 1851, for "Gas-Retorts and other Objects in Fire-Clay," and they were also awarded at the International Exhibition of 1862, the Prize Medal for "Gas-Retorts, Fire-Bricks, &c., for Excellence of Quality."
J. C. and Co. have been for many years the most extensive Manufacturers of Fire-Clay Retorts and Fire-Bricks in the Kingdom. Orders for Fire-Clay Retorts of all shapes and dimensions, and to fit any shaped Mouthpiece, Fire-Bricks, and every other article in Fire-Clay, are promptly executed at their Works as above.
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Jos. Cowen & Co. are the only Manufacturers of Fire-Bricks and Clay Retorts at Blaydon Burn.

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Established at the commencement of Gas Lighting,
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TUBES AND FITTINGS.
THREE PRIZE MEDALS,
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MANUFACTURERS OF
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PATENT COMPENSATING METERS,
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TELESCOPIC & SINGLE GASHOLDERS,
CAST & WROUGHT IRON TANKS FOR DITTO,
And Gas Apparatus of every Description.
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THE
"OTTO" GAS-ENGINE.
See Page 166.

CROSSLEY BROTHERS,
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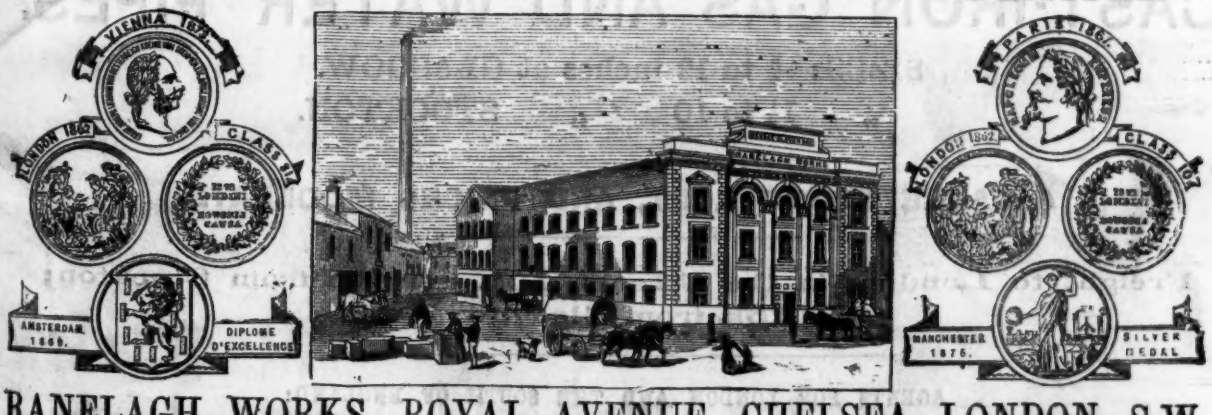
DRY GAS-METER MANUFACTURERS,
HAVE REMOVED TO MORE EXTENSIVE PREMISES:



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Largely used by Gas Companies, Corporations, Railway Companies, Ironfounders, and Machinists. It has the following qualifications and properties:—

EFFECTUALLY PREVENTS AND ARRESTS CORROSION.
HAS A FINE GLOSS, AND IS VERY DURABLE.
DOES NOT REQUIRE DRIERS LIKE OTHER PAINTS.
PROTECTS IRON FROM ACTION OF WATER.

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IS CHEAPER AND MORE ECONOMICAL THAN ANY OTHER.

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THE UNVARYING WATER-LINE GAS-METER,

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IMPROVED DRY GAS-METERS;

STATION-METERS OF ALL SIZES, with PLANED JOINTS;

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HYDRATED PURIFYING MATERIAL.

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IMPROVED HYDRAULIC CRANES,

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Sixteen recently erected at Beckton, applied to Covers 30 feet square.

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IN SUCCESSFUL OPERATION AT THE NEW WORKS OF THE NEWCASTLE AND GATESHEAD GAS COMPANY, AND IN COURSE OF ERECTION AT THE CARLISLE CORPORATION GAS-WORKS.

Special "REGULUS COCKS" manufactured to stand Acid.

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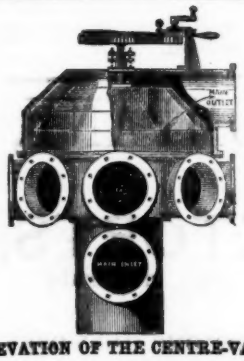
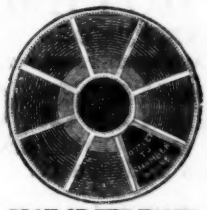
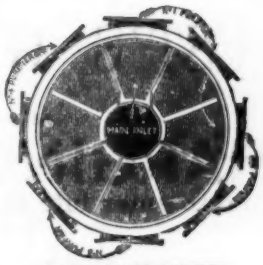
C. & W. WALKERS'
PATENT CENTRE-VALVES.



ELEVATION OF THE CENTRE-VALVE.



PLAN OF THE VALVE.



PLAN OF THE BODY.

These PATENT CENTRE-VALVES are the most perfect and certain means for working Purifiers on the system of three in action, and one out of action. The Valve itself is protected from all injury inside the safety cover. The working of the Valve is so easy, and so governed by the stop-catch movement, that the Purifiers can be instantaneously changed in the dark as well as in daylight. They are scraped perfectly true, metal to metal, the facings heretofore exposed are always covered, and there is nothing more reliable, certain, and durable in a gas-works. By their use the floor of the Purifying-house is clear and level; the Valve and all connexions being beneath the floor, out of the way of working. A considerable improvement and saving is effected in the cost of the connecting-pipes.

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INVITE THE ATTENTION OF GAS COMPANIES AND OTHERS FOR THE SUPPLY OF

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And every description of Gas Machinery.

TENDERS GIVEN FOR WORK FIXED COMPLETE IN ANY PART OF THE KINGDOM.

WEST'S GAS IMPROVEMENT COMPANY,

LIMITED,

ARE NOW PREPARED TO SUPPLY AND ERECT THEIR PATENTED MACHINERY FOR

CHARGING AND DRAWING GAS-RETORTS,

And to enter into arrangements with GAS COMPANIES for its use upon moderate terms of Royalty.

The Patented Machinery has secured the approbation of all Engineers who have visited the MAIDSTONE GAS-WORKS, *where it is in full operation, and may be inspected at any time on application to the Manager.*

The advantages attending its use are—

INCREASED VOLUME OF GAS PER TON.—INCREASED YIELD PER RETORT.—INCREASED BULK OF COKE FOR SALE.—REDUCTION IN LABOUR AND LESS DEPENDENCE ON SKILLED STOKERS.

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FOR PURIFIERS, GASHOLDERS, BYE-PASS, AND OTHER ARRANGEMENTS REQUIRING VALVES IN GAS-WORKS.

The Faced Valves, as made by the Patentees, continue to give great satisfaction, and they are being used extensively by many of the best gas engineers of the day.

They are more easily repaired than any other kind of Valve in use, and can be re-ground in a few hours without removal, and made perfectly gas-tight.

References can be given to many Engineers of high standing, who will testify as to the favour in which they are held.

MANUFACTURERS ALSO OF SUPERIOR WOOD GRIDS FOR PURIFIERS, SCRUBBERS, &c.

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WET AND DRY GAS-METERS,

STATION-METERS, GOVERNORS,

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LAMP-METERS IN CAST-IRON BOXES,

And every Description of Gas Apparatus.

JAMES MILNE & SON,

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Gas-Meter, Gas Apparatus, and Gas-Fittings Manufacturers,

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STATION-METERS GOVERNORS, CONSUMERS METERS, GAS LUSTRES, CHANDELIERS, BRACKETS, &c.,

And every description of Gas-Fittings and Gas Apparatus.

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DIRECT FROM THE

MARQUESS OF LONDONDERRY'S COLLIERIES.

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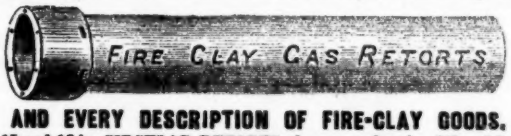
Manufacturers of FIRE-BRICKS, LUMPS, TILES,



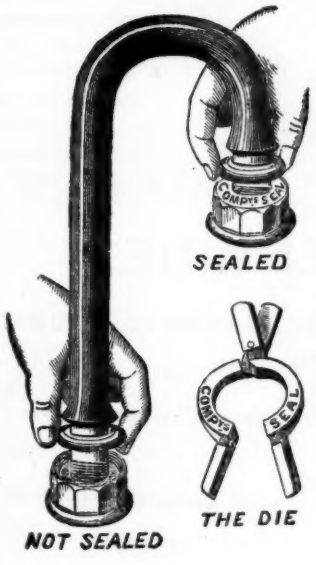
AND EVERY DESCRIPTION OF FIRE-CLAY GOODS.

N.B.—A Stock of 15 and 16 in. CIRCULAR RETORTS always on hand. Other kinds made to order on short Notice.

FOULGER'S PATENT

COUNTER-SUNK SEAL GAS-METER UNIONS,

As Supplied to The Gaslight and Coke Company.



These Unions practically place a Gas Company's property under lock and key, by rendering it impossible to disconnect at any joint at which gas could be obtained unregistered, without destroying the Company's seal or signature, whilst a small cover absolutely protects the impression from accidental injury.

A meter having been fixed with one of these Unions on the main-cock, and another on the inlet, a few pinches of specially prepared crushed sealing-wax is placed in the cup, and being melted with a blow-pipe, the wax runs between the reversed threads, the circular tong-shaped die will then give a sharp impression of the Gas Company's title, an operation requiring about two minutes in all to perform.

If heat is applied for the purpose of unsoldering the joints, the wax is instantly fused, and the impression, of course, lost.

Are supplied in all sizes, either as Caps and Linings or Barrel-Unions, and at a small additional cost over existing connections.

For further Particulars, Samples, &c., apply to the Sole Agents,

WIGGINS & RIHLL,

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C. & W. WALKER'S

WOOD PURIFIER SIEVES,

Which have now been used for fifteen years, and their advantages and durability fully established. They are made entirely by steam machinery in very large quantities at the most moderate cost.

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FINSBURY CIRCUS, LONDON.

ESTABLISHED IN 1860.

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THE ORIGINAL MANUFACTURER OF THE IMPROVED

WOOD SIEVES

FOR

GAS PURIFIERS & SCRUBBERS.

PROVIDENCE WORKS,

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The Dunston Engine Works Co.,

GATESHEAD-UPON-TYNE.

Are the Sole Manufacturers of

Archer's Patent Hoists,

ALSO OF

Archer's Patent Stone Breaker,

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Archer's Patent Ore Crusher & Pulveriser,

The last-named Machine (without the Pulveriser) makes the best and most durable Coke Breaker.

GRIRDROD'S PATENT

PORTABLE PIPE SCREWING MACHINE,

For 1 in., 1¼ in., 1½ in., and 2 in. Gas Threads, complete £7 10s.

In use at the chief gas-works, and giving great satisfaction.

For other useful goods, see Bailey's "Illustrated Inventions," post free 3s. 6d.; gratis to ledger customers.

W. H. BAILEY & CO.,

Brassfounders, Gauge Injector and Tool Makers,

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Gold Medal Awarded, Paris Exhibition, 1878.

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SHEAF AND SPRING WORKS,

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MANUFACTURERS OF

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FOR ENGINEERS,

STEEL OF ALL DESCRIPTIONS,

SCREW STOCKS, TAPS, AND DIES, SPANNERS, RATCHET BRACES, LIFTING-JACKS, ANVILS, VICES, AND ENGINEERS TOOLS GENERALLY.

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ALPHA TUBE & FITTING WORKS

Manufacturers of W. J. WARNER'S PATENT MARKET GAS STAND-PIPE.

Now ready, GAS CHANDELIER BOOK (Reduced Prices), 7s. 6d.

THE WIGAN COAL & IRON COMPANY,

LIMITED,

DISTRICT OFFICE: 97, NEW STREET, BIRMINGHAM; AGENT: W. M'GOWAN,

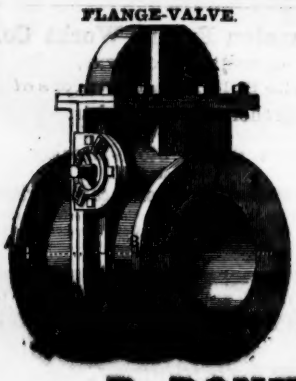
Supply the Best Wigan Arley Mine Gas Coal, Gas Nuts, Gas Cannel, &c.

N.B.—The Wigan Coal and Iron Company, Limited, are exclusive owners of the well-known HAIGH HALL AND KIRKLESS HALL GAS COAL COLLIERIES.

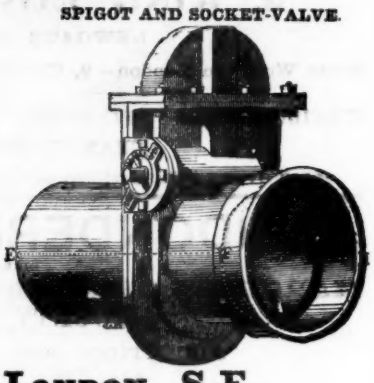
IMPROVED GAS-VALVES

With Wrought-Iron Pinions.

FLANGE-VALVE.



SPIGOT AND SOCKET-VALVE.



List of Prices, with dimensions of all Sizes up to 48 inches, to be had on application.

These Valves are proved on both sides to 30 lbs. on the square inch before leaving the works, and are kept in stock.

In ordering, please state whether required for under or above ground, and if to be with flanges or spigots and sockets cast on, or with separate spigot and socket-pieces.

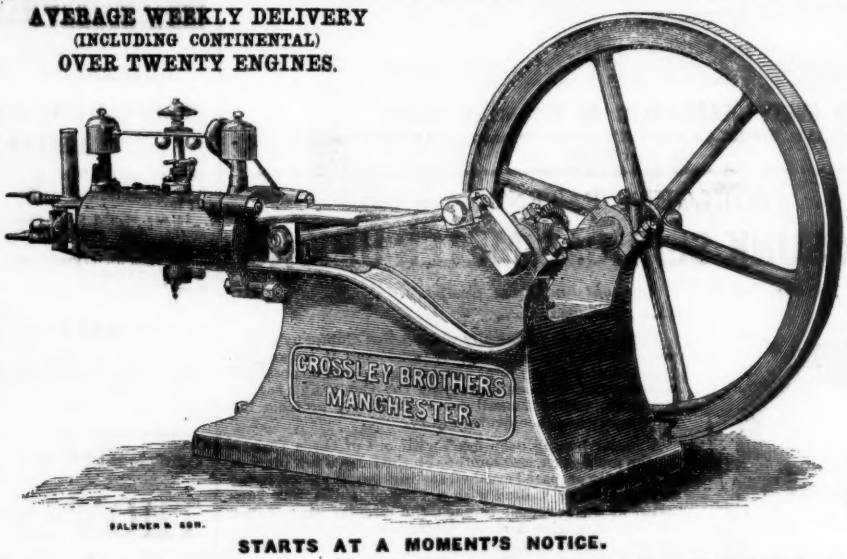
B. DONKIN & CO., BERMONDSEY, LONDON, S.E.

Also Makers of Steam-Engines, Beale's Exhausters, Water-Valves, &c.

AN ENGINE WHICH WORKS WITHOUT A BOILER OR STEAM

AVERAGE WEEKLY DELIVERY
(INCLUDING CONTINENTAL)
OVER TWENTY ENGINES.

The durability of these Engines is now established by experience, one of them having run night and day at the Hinckley Gas-Works for over Twelve months without any expenditure for repair; this being equal to about 2½ years average work.



Over 1900 already delivered.

Very numerous Testimonials from Users, including Engineers, Men of Science, and others, on application to the makers.

No trouble with Coal, Ashes, Smoke, Insurance, Water, or constant attendance.

No Glands to pack, or Water Gauges and Steam Gauges to watch.

STARTS AT A MOMENT'S NOTICE.

THE "OTTO" SILENT GAS-ENGINE.

(Otto and Crossley's Patents, 1876 and 1877.)

THEY ARE USED FOR ALL KINDS OF PURPOSES, CHIEFLY FOR EXHAUSTERS, SCRUBBERS, & PUMPS.

DELIVERED IN MANCHESTER. SIZES { NOMINAL HORSE POWER ½ 1 2 3½ 6 8 12 16 / MAXIMUM HORSE POWER ¾ 1½ 2½ 4 9 12 18 24 } OFFERED. CASES NOT CHARGED IF RETURNED FREE

PRICES INCLUDE CAST-IRON STAND, TURNED FLY-WHEEL, AND DRIVING PULLEY; WATER-VESSEL, SEVERAL DUPLICATES, AND GAS-FITTINGS (EXCEPTING METER AND PIPES).

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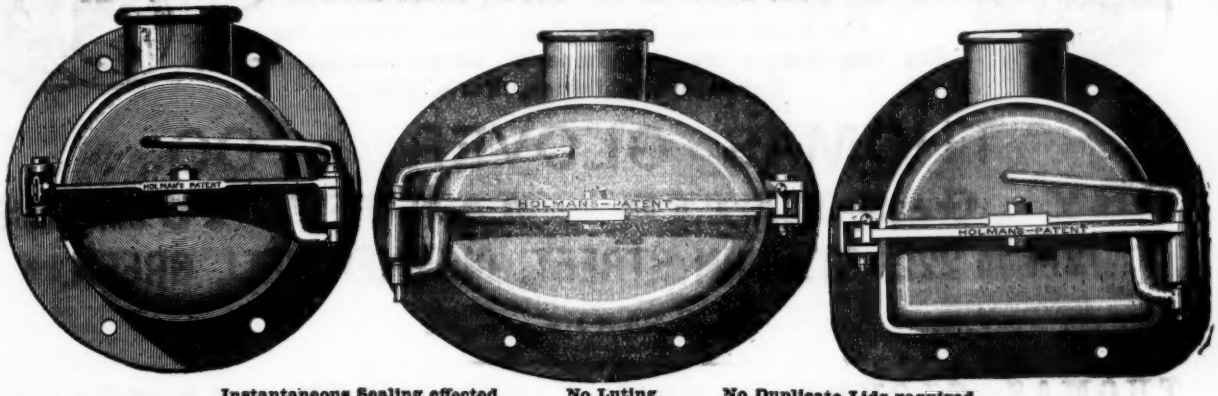
CORNWALL HOUSE, 35, QUEEN VICTORIA STREET, LONDON, E.C.,

(LATE OF 10, LAURENCE POUNTNEY LANE.)

SOLE MAKERS OF MORTON'S PATENT SELF-SEALING RETORT-LIDS,

WITH HOLMAN'S PATENT ECCENTRIC FASTENINGS,
Anti-Friction Catches, and New Self-Adjusting Cross-Bars.



Instantaneous Sealing effected. No Luting. No Duplicate Lids required.
Holman's New Self-Sustaining Cross-Bar ensures freedom of Joint, and maintains parallel position of the Lids.

Since their introduction in 1869, these Patent Retort-Lids have been thoroughly tested, being now in use in nearly all the principal Gas-Works in London and the Provinces.

T. B. and H. are now making the "Morton's Self-Sealing Lid" of the SAME FORM OR SECTION AS THE RETORT (see Illustrations above), as well as bringing the Mouthpiece from the D or Oval at back to Circular in front, as heretofore.

D and Oval Morton's Lids are working satisfactorily both in this country, on the Continent, and in the United States of America. Among others they have been adopted by the following Gas-Works:—

The Gaslight Company's Works, Fulham; Ditto, Bromley-by-Bow; Ditto, King's Cross; Ditto, Shoreditch.
And also in the Gas-Works at Richmond, Maidstone, Gloucester, Glasgow, Portsea, Roubaix (France), The Hague (Holland

HUNT'S PATENT EQUILIBRIUM GAS-GOVERNOR.

In this Governor a Throttle-Valve is substituted for the ordinary suspended Cone, all external communications being avoided by placing the Lever or Radius Arm (shown in the drawing) inside the Valve-Chamber upon the Disc. The Disc is carried upon steel centres, upon which it is accurately balanced and turns freely. The friction in working is thereby reduced to a minimum. This Governor is extremely sensitive to alterations of inlet or outlet pressure, and renders a large actuating holder unnecessary.

The principal advantages of this arrangement over the ordinary form of Governor are as follows:—

Its sensitive action prevents oscillation.

It is self-adjusting—*i.e.*, it maintains a steady pressure under variations of inlet pressure or a fluctuating consumption.

The inlet to Gasholder being contracted to the smallest possible dimensions, all danger from leakage through insufficiency of seal, tilting, &c., is entirely avoided.

The valve portion being separate from the holder, it can be handled and fixed like an ordinary Slide-Valve direct in the main; and the holder can be placed at an convenient distance immediately above it. The cost is thus materially reduced, and the inconvenience of heavy lifts done away with.

There are no working parts likely to get out of order.

These Governors have been adopted by many leading Gas Companies, among whom are the following:—

The Gaslight and Coke Co. (9), The London Gas Co. (3), and at Abergavenny, Arundel, Birmingham, Cannes (France), Devonport, Dursley, Exeter, Guernsey, Halesowen, Mentone (France), Monmouth, Newcastle-on-Tyne, Oxford, Plymouth, Rochdale, Windsor, &c.

TESTIMONIAL.

The Gaslight and Coke Company,
9, Water Street, New Bridge Street,
Blackfriars, E.C., Feb. 27, 1875.

MESSRS. TANGYE BROTHERS AND HOLMAN.

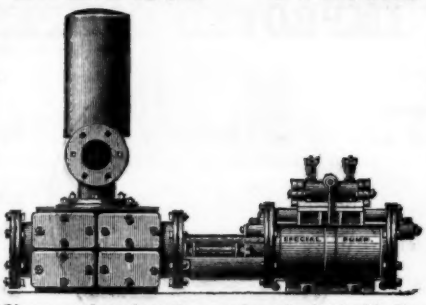
Gentlemen,—The two 24-inch and three 36-inch Hunt's Equilibrium Governors supplied by you, and fixed in the valve-rooms at Whitechapel, Goswell Road, and Blackfriars, are working very satisfactorily.

Yours truly,
(Signed) JOHN JOHNSON.

PRICES AND FULL PARTICULARS ON APPLICATION.

THE "SPECIAL" STEAM-PUMP.

Diameter of Steam Cylinder.	Diameter of Water Cylinder.	Length of Stroke.	Gallons of Water per Hour, Approximate.	Reduced Prices.
3	1½	9	450	£16
4	2	9	815	18
5*	2½	12	1,250*	21
5*	3	12	1,830*	22 10
4	4	12	3,250	25
6*	4	12	3,250*	30
5	5	12	5,070	32 10
7*	5	12	5,070*	40
6	6	12	7,330	40
8*	6	12	7,330*	50
7	7	12	9,750	50
10*	7	12	9,750*	65



In use in a Hundred Gas-Works in the United Kingdom for Pumping Ammoniacal Liquor, Water, or Tar.

Messrs. Burt, Boulton, and Haywood, Manufacturing Chemists, have over FORTY "Special" Steam-Pumps in use at their several large Tar-Works.

Two Hundred Sizes made. Those in Table opposite are the leading Sizes for use in Gas-Works and Chemical Works.

* These Sizes being usually selected for pumping Tar and Liquor, are always in stock, or nearly ready, fitted with all pump details in iron, and extra length distance-piece between steam and pump cylinder, at a small extra cost.

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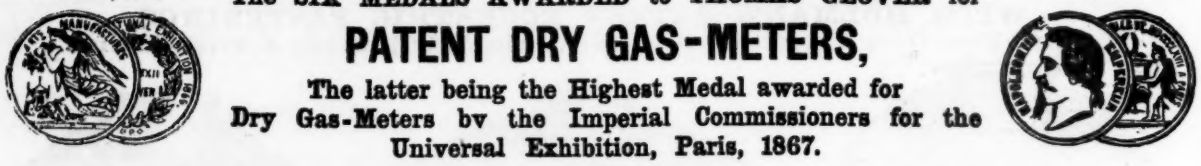
London, 1851. New York, 1853. Paris, 1855. London, 1862.

Dublin, 1865. Paris, 1867.



The SIX MEDALS AWARDED to THOMAS GLOVER for

PATENT DRY GAS-METERS,

The latter being the Highest Medal awarded for Dry Gas-Meters by the Imperial Commissioners for the Universal Exhibition, Paris, 1867.

THOMAS GLOVER & CO.,

DRY GAS-METER MANUFACTURERS,

214 TO 222, ST. JOHN STREET, CLERKENWELL GREEN,

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THOMAS GLOVER & CO.'S PATENT DRY GAS-METERS.

1st, Are a remedy for all the defects of Wet Meters;
2nd, Are suitable for all climates, whether hot or cold;
3rd, Incur no loss of Gas by evaporation;
4th, Cannot become fixed by frost, however severe;
5th, Are the most accurate and unvarying measurers of Gas;
6th, Prevent jumping or unexpected extinction of the Lights;
7th, May be fixed either above or below the level of the Lights;
8th, Cannot be tampered with, without visibly damaging the outer case;
9th, Will last much longer than Wet Meters;
10th, Will not cost more than one-half for repair that Wet or Water Meters do;
Are upheld for five years without charge.

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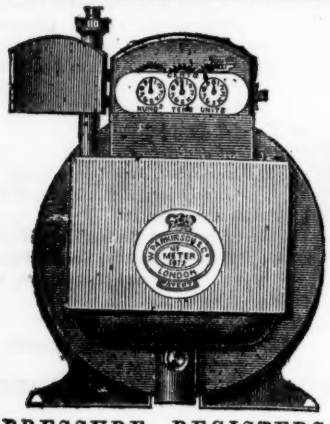

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MANUFACTURERS OF

WET & DRY METERS,

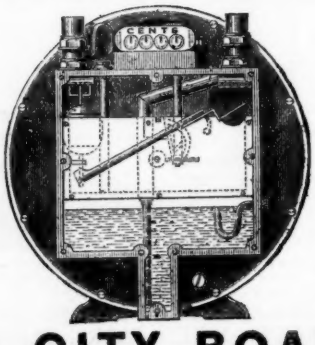
STATION-METERS & GOVERNORS,

EXHAUSTER REGULATORS,

PRESSURE REGISTERS, EXPERIMENTAL APPARATUS, GAUGES, WATER-METERS, &c.

HUNT'S PATENT IMPROVED COMPENSATING METER.

In this Meter, the action of the measuring-drum is reversed. By this arrangement an improvement is effected in the registration at high speeds, which, in many tests, has not varied from the smallest light to three times the capacity of the meter. It works equally well under all pressures. The range of error between the high and low line is much smaller than that allowed by the "Sale of Gas Act."



The Meter has been critically tested, and most favourably reported upon by official Meter Inspectors in London and Birmingham.

W. PARKINSON and CO. have made arrangements for the manufacture of these Meters, both in tin and cast-iron cases, and for the alteration of old ones to this principle, which is confidently recommended as possessing every quality that can be desired by Gas Companies, Corporations, or Private Consumers.

COTTAGE LANE, CITY ROAD, LONDON, E.C.

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NOTICE TO SUBSCRIBERS.

Bank Holiday.—*In consequence of the Bank Holiday next week, the* Journal *will not be published till Wednesday, Aug. 6.*

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion, must be authenticated by the name and address of the writer; not necessarily for publication, but as a guarantee of good faith.

THE JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

TUESDAY, JULY 29, 1879.

Circular to Gas Companies.

Our readers will have learned from our last issue that the Liverpool (Corporation) Lighting Bill passed a Committee of the House of Lords yesterday week, substantially in the form we then mentioned, and it may now may be considered virtually part of the law of the land. Let us consider what the Liverpool Corporation have gained by the passing of this measure. It empowers them to make experiments with the electric light, which may extend over five years, but it forbids them to obtain any profit by a supply of the light to the places which may be open to them. Thus the Corporation may illuminate any public streets or areas and interiors, properly belonging to themselves, at a cost price which can be easily estimated. But the Bill gives further power to the Corporation to supply places of public resort, such as theatres, music halls, and railway stations, and these must be supplied without profit. The pretence for acquiring power to light these latter was, that the expense of the light could not be ascertained unless some of it was sold, although without profit. Now that the Corporation have these powers, we shall be curious to see how and when they will be exercised. The excuse for granting powers of this kind to Corporate Authorities rather than to Gas Companies is, that the former are likely to do their utmost to promote the success of the new light, while the latter, it is alleged, would endeavour, so to speak, to smother an invention which professed to rival the light they already purvey. The absurdity of this supposition is palpable. If Gas Companies went in for the supply of the electric light, they would do it *con amore*, and with a view to make a profit. As things now stand, the Liverpool Corporation may engage in the supply of the electric light, but, as a matter of fact, they have but one inducement, and that is antagonism to the interests of the Gas Company.

It was very well and fairly put before the Committee of the House of Lords, when it was said that the object of the Bill promoted by the Corporation was simply to cheapen the undertaking of the Liverpool United Gas Company. We question whether, in their hearts, the Town Council of Liverpool have the smallest intention to seriously experiment. They have five years before them, but at the present time only one invention offers itself for public and partially internal utility. That is the Jablochkoff system, which Mr. Deacon saw in operation in the Avenue de l'Opéra, at Paris, and did not report on in very favourable terms. This system is still on trial on the Victoria Embankment, and the results of the extended experiment we shall learn in about six or seven months time. Beyond this, two or three other schemes are offered to the Corporation for experimentation. There is, for example, the Lontin light, which, we are bound to say, answers remarkably well in single instances, but has not succeeded so far as to induce Mr. Hollingshead, of the Gaiety Theatre, in the Strand, to push it into public notice. Then there is the Rapieff system, which commands attention in some interiors, and promises to be effective. Lastly, we have the Werdermann light, which offers the advantage of a more minute subdivision of an electric current, so that smaller lights may be available for internal illumination without much loss of power for the supply of larger lights exteriorly. We need scarcely mention here Mr. Edison's invention, for it seems to exist only on paper—at all events, while inventors come from all parts of the world with their electric lights, Mr. Edison stays at home with his. So far, then, the Corporation of Liverpool have a choice of several systems with which they may set to work at once. There is the Picton Reading Room, about the lighting of which they are so anxious; there is the St. George's Hall, with the steam-engine in the cellar, and the large space in front of the Hall ready for experiment; but still we expect delays. If the Corporation had simply desired to assist in developing the science of electric lighting, they might have begun the work a year ago without any special sanction from the Legislature; but, as said above, their antagonism to the Gas Company has sent them to Parliament, where we do not see they have gained much. The privilege of selling without a profit can hardly be considered as worth having. Nevertheless this would appear to be all that the Corporation have received for their money. The rather wide powers they have obtained for squandering, we do not expect will be much drawn upon, though it may be that at the end of five years a quantity of old iron will be found in the Liverpool market.

The question whether gas loses in illuminating power by travelling through long lengths of mains, is likely presently to attract a good deal of attention. It is proposed to abolish the thousand yards limit, at which distance all Gas Acts now fix the place where examinations shall be made. This limit, we believe, was first settled—we write from memory—upon the result of experiments made by the late Dr. Letheby, on the gas of the Great Central Company, as it travelled from the manufacturing station, on Bow Common, to the testing-place in Coleman Street, City. Within these limits, far exceeding one thousand yards, no appreciable loss of power was sustained. Since those experiments were made, we do not remember that any have been carried on, having a special reference to the alleged loss of power, while certain observations seem to have shown that little or no deterioration of quality takes place even when long lengths of mains are traversed. The gas of the late Birmingham and Staffordshire Gas Company was tested at stations several miles apart, and very little or no loss of power was observed. So, too, in the case of the Chartered Company's gas, which was tested by independent Examiners at Beckton within the thousand yards limit, and at Cannon Street, City, six or seven miles distant from the works. Here, again, the reports of the two Examiners showed great uniformity. While, then, we strongly object to any alteration of the law which affects the limit, and think that Gas Companies ought to oppose the Bill to be brought in next session to extend the distance, which, for all that we know, might prove prejudicial to their interests, the matter may be found of little importance.

History repeats itself at the police courts and in the newspapers. A man who gets into houses under the pretence of being sent to examine the gas-meter, is constantly figuring. We notice a recent case for the sake of a suggestion made by a newspaper correspondent—namely, that the servants of Gas Companies should be provided with some proof of identity.

We should not care to see them provided with a small bone ticket like those the genuine dustman used to carry to distinguish themselves from the shams who were prone to anticipate them in the collection of Christmas-boxes. All Companies might do as one suburban Company does, and put their outdoor servants into livery. It would prove a little expensive, but it would at once stop the "shams," whose only object is to possess themselves of silver spoons and other trifles that may be within reach.

We commend our readers attention to a paper by Mr. Rutter, of Brighton, on what he calls distribution, by which he means dividing the flow of gas on its way from the hydraulic, so as to ensure a speedier fall of temperature and condensation. No doubt the arrangement suggested by the writer is a very effective one, and will answer all the purposes he proposes to accomplish, so that it will be found useful in works of the size Mr. Rutter superintends at Black Rock. If naphthaline be kept back by the use of the apparatus, a great gain will have been effected, and numerous gas managers will bless the writer for the invention of a simple form of apparatus which will relieve them of many difficulties.

We commence to-day the publication of the papers read before the recent meeting of the North British Association of Gas Managers. The first is one which mainly concerns managers who are engaged far North, where frost is liable to considerably affect their product and plant. All such managers will be grateful to Mr. Watson, the author of the paper on "The Effects of Frost on Gas Apparatus," in which he shows so clearly how to avoid the consequences which follow the congelation of aqueous vapour and water in gas-holder-tanks, in mains, and in services. The discussion was of an extremely interesting and valuable character, and to our Scottish friends, who, according to our meteorological prophets, are to be exposed to a cycle of hard winters, the information will be of great utility. We may mention that methylated spirit is perhaps the best substance which can be used for preventing the freezing of water in mains and meters. To prevent the freezing of water in gasholder-tanks, nothing could be better than the use of steam, as proposed by Mr. Whimster.

The second paper, by Mr. Young, of Clippens, entitled "The "Elimination of Sulphur Compounds from Illuminating "Gas," was of very considerable interest. If we understand his paper rightly, he would start with some waste products from shale gas, which will, no doubt, have a strong affinity for, and will immediately absorb bisulphide of carbon. The modes in which the fluid are to be employed seem various, and we must commend our readers to the perusal of Mr. Young's paper for the methods by which it is to be used for eliminating bisulphide of carbon. It looks curious that the fluid, after having been employed in abstracting bisulphide of carbon, is recommended as a carburetting agent. Now it seems that to take bisulphide of carbon out of gas, and then to put it back again, is a strange way of accomplishing what gas managers desire. The object proposed to them is to take out the bisulphide, so that, when burned, it may not act prejudicially on furniture, &c. We want to get rid of the stuff completely, and Mr. Young's paper offers but limited means of accomplishing this end. We doubt whether, if moist hydrate of lime were still further wetted with the fluid—that is, the waste shale oil in which bisulphide of carbon has been absorbed—any considerable condensation of bisulphide would take place. It is a very different thing bringing aqueous and oily solutions into union with gas. We recommend our readers in the South to peruse this paper, think over its points, and set to work to see how far it will be useful to them.

THE ANNUAL EXCURSION OF THE EMPLOYÉS OF THE CRYSTAL PALACE DISTRICT GAS COMPANY.—Last Tuesday a very enjoyable day was spent at Brighton by one-half of the officers and men connected with the Crystal Palace Gas Company, together with their wives and friends, the other half having been similarly treated the previous week. An early start, by special train, was made, which allowed for spending nearly ten hours at the sea-side; and the weather, fortunately, being fine, a most successful outing resulted. At one o'clock, all assembled in the Pavilion, where a substantial dinner was served; and at its close the Secretary of the Company (Mr. Magnus Ohren) called for three cheers for the Directors, by whose liberality the whole of the expenses of the day were met. This was heartily responded to, and similar compliments to Mr. Ohren and to the Engineer (Mr. Charles Gandon) were as lustily accorded. Tickets of admission to the Aquarium having been provided, the majority of those present adjourned thither to spend the afternoon. A tea in the Pavilion at half-past five followed; and the company separated to re-assemble for the return journey at eight o'clock. As we have said, a most enjoyable day was spent, and those who had the management of the arrangements are to be congratulated on their success. Similar excursions in connection with other companies would do much to promote kindly feeling among fellow-workmen, and would afford opportunity of friendly intercourse which could not otherwise be found.

Water and Sanitary Notes.

WE see an announcement that a meeting is to be held in Exeter Hall on the 6th of August, to consider the best means to be taken to consolidate the Metropolitan Water Companies under unity of management. Some influential philanthropists are to take part in the proceedings, and Mr. Watherston, of St. Martin's-in-the-Fields notoriety, is said to have a scheme cut and dried for handing over the undertakings to some central authority—we are not as yet told what—who are to manage them for the benefit of the ratepayers. Mr. Watherston's plan is said to involve the acquisition of the works without the necessity of raising money for the purpose, and he intimates the possibility of saving £100,000 per annum by obtaining unity of management. It will be seen that, so far as we know, no revolutionary objects are in view. The Water Companies are to be taken as they stand, and beyond the abolition of Directors seats and the supercession of Engineers and Secretaries, we may take it that nothing more is contemplated. The sources of supply will, at all events for the present, remain as they are, and the movement on the part of Mr. Watherston seems to involve an admission that no better can be obtained. Cardinal Manning's teetotal friends now drink the water, enjoy it, and thrive upon it. They are not driven to the public-houses by water which many denounce as unfit for dietetic purposes. They may go to coffee palaces and taverns, and get the "washy stuff"—we speak with all respect—sold under the name of "coffee," and possibly may think that they are evading the consequences of drinking Thames water. They have, it is true, the advantage of boiled water, which may or may not be of importance. At all events, we shall not quarrel with the temperate working man who drinks what is called "coffee" at a palace or a tavern, in preference to taking wholesome water at home in the bosom of his family.

As our readers know, the combination of the water undertakings sketched out by Mr. Watherston is not that which we advocate. We have consistently urged the desirability of the Companies uniting among themselves, with a view to do all that can be obtained by Government management or an independent Commission. It has been put to us by a friendly correspondent, that the great obstacle in the way of union between the Companies rests on the fact that they have statutory powers to charge different rates for supply. Some, for example, have power to charge 4 per cent. for houses of certain rateable value, and others have the right to make a charge of 7½ per cent. We do not regard these differences in rates as any invincible obstacle to the union. We admit that the rights of certain Companies might be somewhat seriously interfered with if a levelling-down process were adopted; but it must be remembered that we stand at the present moment in an unparalleled position. Public feeling is being aroused, and we must prepare ourselves for possible eventualities. The solution of the question which now agitates the Metropolitan mind is simply this: Shall the London Water Companies combine and do their best to comply with popular demands, or shall the Government or some Central Authority interfere, and take over the undertakings? We feel satisfied that if the Companies will dispassionately consider the whole matter, they can so arrange affairs that every public demand shall be satisfied, and their own interests at the same time completely protected.

Since the above was written, we understand that the Government have given Mr. Fawcett an evening to bring forward the motion which has been standing in his name since the beginning of the session. It will come on on this night week, and is contained in the following terms:—That this House is of opinion that serious deficiencies exist in the quality and mode of supply of water to the Metropolis, and great burdens are imposed upon the inhabitants by the charges made by the different Companies; and further, that, for a satisfactory solution of the question, seeing that the Metropolitan Board of Works have failed to pass any measure dealing with the water supply of London, it is a subject which ought without further delay to be dealt with by the Government. We are glad to see that at last an opinion is to be, so to say, forced from the Government as to the advisability of their taking over the water supply of the Metropolis. A definite opinion on this point will do much to allay a certain amount of uneasiness which affects the minds of holders of Metropolitan water stock and shares. A distinct announcement from the Government of their views on the subject is desirable for two classes of people. First of all, ratepayers are anxious to know what may possibly result in the way of reduction in charges and a better supply, if such

be possible, from Government superintendence; and then the share and stock holders are very desirous of knowing how their interests will be affected by a transference of the powers of the Companies in which they have invested their capital, to some Central Authority. This is a much larger question than some people seem to think. To not a few it appears a very easy matter to transfer, say, £20,000,000 worth of property from one hand to another; but, as a matter of fact, great difficulties attend this change of ownership. We are here simply thinking of the financial part of the matter; but, as regards the real business of the undertaking—that is, the supply of water—more difficulties would have to be encountered before the Government can see their way clear to assume the control of the supply. Supposing, as every one must, that the present Metropolitan Water Supply is wholesome and adequate, what can the Government or any Central Authority do? They may, if they like, insist on a constant supply, in regard to which they have not been helped by the Metropolitan Board of Works, or any other body beyond the Corporation of the City of London; but there the exertions of a new Water Authority must end. They cannot, so far as we can see at present, change the quality of the supply. To add to the quantity would be entirely superfluous; and as to the rates, we are satisfied that when any authority entrusted with the supply come to consider them in relation to the cost—for water does cost something—they would find that very little, if any, alteration was possible.

A town's meeting at Wakefield, under the Borough Funds Act, 1872, was held last week, at which sanction was obtained for the promotion of a Bill to carry out the new scheme for supplying Wakefield and the neighbourhood by a catchment system on Rishworth Moors, near Ripponden. The water supply of Wakefield has, among sanitarians and chemists, so long been considered a disgrace, that we are glad to see the prospect of a new supply, be it even a brown coffee-coloured infusion of peat from the Rishworth Moors.

Sale of New River Company's Shares.—At the Auction Mart, Tokenhouse Yard, E.C., on Wednesday last, Messrs. Edwin Fox and Bousfield offered for sale one-fifth and one-fifteenth of a King's moiety, and twenty-five £100 new shares in the New River Company. The original shares have realized prices ranging from £90,000 to £98,000 each, the last dividend paid thereon being at the rate of £2200 per annum. The new shares last year carried a dividend of £10 3s. 8d. each. The portions of the King's moiety offered on Wednesday were put up in 38 lots, consisting of thirty 150ths and eight 120ths, the former realizing prices ranging from £590 to £540, and the latter from £740 to £730. The total amount produced was £22,450, being an average of £552 13s. 4d. for the 150ths, and £733 15s. for the 120ths, or at the rate of about £82,800 and £88,000 respectively for the entire share. The £100 new shares were sold—four at £330, and twenty-one at £325, realizing a total amount of £8145, or on an average £326 per share. The prices all through were somewhat lower than those hitherto obtained for the New River Company's stock, the original shares of which are freehold estate, and confer on their holders voting powers for the counties of Hertford and Middlesex.

Arbroath Gas Corporation.—A meeting of the Arbroath Corporation Gas Commissioners was held on Monday, the 14th inst.—Provost Shield in the chair. The Clerk submitted the abstract of accounts of the Corporation for the year ending May 31, 1879. It showed that the total income from all sources was £9238 14s. 5d., of which the sum of £8118 9s. 4d. was derived from the sale of gas and from meter-rents. The balance of surplus revenue and profits on the year's transactions was £740 7s. 6d., notwithstanding the reduction in price last year. The accounts also showed that £200 had been paid to account of the new condenser, £100 to the retort suspense account, as well as £200 into the sinking-fund. The loan account of £13,050 was reduced by the sum of £1000, which was repaid during the past year. An interesting report was also submitted by the Manager (Mr. Terrace). The quantity of coal (average cost per ton, 19s. 8½d.) used was 3308 tons, from which 35,140,000 feet of gas were made, being an average make of 10,621 cubic feet, or an average increased make of 270 feet per ton over the make in the previous year; and the gas sold per ton of coal carbonized was 9332 feet, being an increase of 440 feet, or 5·1 per cent. over that of the preceding year. During the past year the unaccounted-for gas was 12 per cent. of the quantity made, as against 13·5 per cent. in the preceding year, and 17 per cent. in the year 1875; so that the returns for the past year, as compared with those of 1875, show a saving in the item of leakage amounting to £440. There were 5203 consumers during the past year, compared with 5128 in the year ending May, 1878; and the amount paid for gas per consumer was £1 9s. 5d. in the past year, as against £1 14s. 2d. in the preceding year, the decrease of 4s. 9d., or 14 per cent., per consumer, being due to the fact that the net price of gas was reduced 8d. per 1000 feet. After some discussion—a large portion of which seemed to be captious criticism and fault-finding on the part of one of the Commissioners—the accounts and the Manager's report, which were held to be satisfactory, were unanimously approved; and the Board resolved, in terms of the Act of Parliament, to transfer one-half of the profits to the Town Council for public improvements, the other half to go to the consumers in the shape of a rebate of 2½d. per 1000 feet of gas. It was subsequently agreed, by a majority of 7 to 6, to fix the price of gas for the year at 5s. 2½d. per 1000, with a rebate of 2½d. The minority of the Commissioners, including the Provost, were in favour of the price being 5s. 5d. per 1000 feet, with a rebate of 2½d. The question of the workmen's hours at the gas-works was again brought up for consideration by one of the Commissioners, who was formerly the Manager. He moved, in accordance with a notice previously given, that the working hours of the men at the gas-works be reduced from 84 to 56 per week. A long discussion took place on the subject, in the course of which it was stated that the men had expressed themselves satisfied with the present system, and that from inquiries made by the Works Committee at about twenty other works in towns of similar size to Arbroath the same system was adopted in about three-fourths of them. The motion was eventually rejected.

Communicated Articles.

EXPERIMENTS WITH GENERATOR FURNACES.

VI.

By "Isca."

The Composition of Clinker.

These experiments have brought into such prominence the subject of the clinker formed from gas coke, that the impression raised in the mind of any reader of the records of Dr. Bünte's labours must naturally be, that the composition of such an important but troublesome substance requires to be thoroughly inquired into. This we shall find has been done very carefully, and the results are now given in the following statement.

In the analysis of the variously derived clinkers, only those constituents which formed the greatest bulk of the substance, or which might influence its fusibility, were taken into consideration. These included silicic acid, clay or aluminous earth, oxide of iron, lime, and magnesia. Other matters, such as sulphur, sulphuric acid, phosphoric acid, potassium, and protoxide of manganese, were left out of the calculation, partly because of their occurrence in such insignificant quantity, partly because of their varying proportions, and also because an exact determination of them was unnecessary for the due prosecution of the inquiry. Commencing with outward appearance, there was considerable difference noticeable in clinker from the same coke, produced under identical conditions. Sometimes clinker was observed to contain grains of metallic iron in its hollows, and sometimes oxide of iron and oxide of manganese had melted, together with silicic acid and alumina, to form glass, and occasionally sulphuret of iron was found, which, when water was poured on the hot clinker, caused an evident disengagement of hydrogen sulphide. The various forms in which iron was found were not separately enumerated, but all the iron present was estimated as oxide.

The particulars of the analysis of the clinker obtained from the slit-generator are, in the following table, arranged in the order in which the various kinds of coke were gasified.

Widely different propositions have been adduced to explain the results of the analyses, and to determine the fusibility of the clinker. In general, the proportion of refractory constituents (silicic acid and alumina) to the bases (iron oxide, lime, and magnesia) is decisive. It would, however, be difficult to draw from its chemical composition any exact conclusion as to the fusibility of clinker, because not only the quantity of bases present, but their character, is of influence in the formation of more or less fusible glass. The alumina also acts as an acid or a base, according to circumstances, and this tends to complicate matters still more. In spite of numerous experiments, the influence of fluxes in various mixtures, on the melting point of the less fusible matters, has not been made clear.

Calculating from the analyses the relation of silicic acid + alumina to the total fluxes = oxide of iron + lime + magnesia, the following is the order in which the clinkers will have to be arranged, in which the least fusible are placed first:—

Bohemia coke (Littitz)	5·55
Westphalian coke (Consolidation)	4·40
Saar coke (Heinitz I.)	4·15
English coke (Leverson Wallsend and Dean's Primrose)	2·42
Oberschleswig coke (Luisen-Grube)	1·52
Saxon coke (Forstschacht)	1·08

Composition of Clinker from Various Kinds of Coke.

Constituents.	Saar Coke	Bohemian Coke.	Saxon Coke.	English Coke.	Westphalian Coke.	Oberschleswig Coke.
Silicic acid (SiO_2)	51·90	51·43	33·62	48·00	50·82	38·47
Alumina (Al_2O_3)	25·27	32·91	18·24	24·82	28·09	20·86
Iron oxide (Fe_2O_3)	12·33	11·57	25·62	19·24	15·81	11·62
Lime (CaO)	3·60	2·67	20·10	10·87	2·11	18·41
Magnesia (MgO)	2·66	0·95	2·43	—	—	9·06
$SiO_2 + Al_2O_3$	77·17	84·34	51·86	72·82	78·91	59·33
$Fe_2O_3 + CaO + MgO$	18·59	15·19	48·15	30·11	17·92	39·09

The clinkers of Bohemian and Westphalian coke are the least fusible, as was found by actual experiment. The theoretic fusibility of Oberschleswig and Saxon clinker also corresponds with the observed facts. Bnt the observations made of Saar and English coke are contradictory to the result of the analysis. The clinker of the former is decidedly more like that of Oberschleswig coke than of Westphalian coke, and surpasses both the English kinds in fluidity.

There is another criterion by which the fusibility of clinker may be judged—viz., the quantity of steam necessary to prevent it from melting. When the records of the quantity of steam used for that purpose, with the different kinds of coke in the grate-generator, are examined, the following order will be obtained:—

Bohemian coke	0·49
Westphalian coke	0·53
English coke	0·70
Saar coke	0·71
Oberschleswig coke	0·71
Saxon coke	0·79

For Bohemian coke, with very refractory residue, 0·49 kilo. of steam per kilo. of coke is sufficient to prevent the formation of clinker; but to obtain the same result with Saxon (Zwickau) coke, which is very fusible, at least 0·79 kilo. of steam will be required. These observations, therefore, confirm the experience of slit-generator working, and complete the chemical examination of the clinker.

The influence of clinker on the refractory material of the furnace has already been treated in former portions of the report, as also the

effect which careful management has in the preservation of the same. The ultimate destruction of the furnace lining is, however, only a question of time, for the truly refractory portion of that material is brought in contact with fluxes contained in the clinker, which would eventually destroy even fire-bricks of pure silicic acid and alumina. The result would, moreover, be the same if a material of hard melting bases were used, by the action of the silicic acid contained in the clinker. Dr. Bünte goes on to say that it seems impossible to find anything that could withstand the action of the clinker. This opinion seems to the present writer to be somewhat inconsequent, for it is not clearly demonstrated that the silicic acid of the clinker had any other origin than the fire-brick lining of the furnace itself, which might well have supplied it; consequently, it is open to suggest that if a furnace were constructed of other bases, as above mentioned, the silicic acid to reduce them might not be present at all.

Having done with the actual record of the individual experiments, the Doctor goes on to make a few general remarks on the whole. He states that, in order to judge of the performance of a generator, there must be observed—

1. The quantity of gas produced in 24 hours in proportion to the weight of carbon consumed.
2. The chemical constitution and temperature of the gas so produced.

From the composition of the gas, and its temperature, some conclusions may be drawn respecting the loss of heat in working, and, in order to compare in that respect the different methods of working, some extreme cases have been selected from six series of experiments with different coke, and are shown in the following tables:—

TABLE I.—*Slit-Generator with Slow Draught.*

Description of Coke.	Experiment.	Pressure in Flue. Millimètres.	Kilos. Coke gasified per 24 Hours.	Per Cent. Carbon Gases. CO.	Per Cent. Carbon Gases. CO.	Total Carbon Gases.	Quantity Coke per C.M. of Gas. Kilos.	Temperature of Gas. Fahr.
Saar	A	+0·4	687	1·5	29·2	30·7	·164	750
Bohemian	A	+0·8	741	1·4	29·4	30·8	·165	850
Zwickau	C	−1·1	813	2·7	24·8	27·5	·147	1380
English	C	+1·1	611	2·1	28·5	30·6	·164	930
Westphalian . . .	D	+1·3	542	1·8	28·3	30·1	·161	970
Oberschleswig . .	E	—	518	1·8	29·3	31·1	·167	570

TABLE II.—*Slit-Generator with Quick Draught.*

Description of Coke.	Experiment.	Pressure in Flue. Millimètres.	Kilos. Coke gasified per 24 Hours.	Per Cent. Carbon Gases. CO_2.	Per Cent. Carbon Gases. CO.	Total Carbon Gases.	Coke consumed per C. Mèt. of Gas. Kilos.	Temperature of Gas. Fahr.
Saar	K	−1·4	2817	7·0	23·3	30·3	·162	—
Bohemian	M	−7·2	1686	5·2	23·6	28·8	·154	1615
Zwickau	D	−7·6	1440	6·9	21·5	28·4	·153	2190
English	D	−8·8	2481	4·9	21·5	26·4	·141	1900
Westphalian . . .	E	−6·7	2168	6·0	21·7	27·7	·149	1830
Oberschleswig . .	D	−10	1598	4·8	23·6	28·4	·152	1920

TABLE III.—*Grate-Generator with Proper Steam Supply.*

Description of Coke.	Experiment.	Quantity of Steam per Kilo. of Coke gasified Kilo.	Per Centage of CO_2.	Per Centage of CO.	Per Centage of H.	Per Centage of N.	Carbon Gases per Cent. $O_2 + CO$.	Combustible Gases per Cent. $CO + H$.	Dead Gases per Cent. CO_2N.	Temperature. Fahr.
Saar	*	·71	12·2	17·4	14·0	56·4	29·6	31·4	68·6	—
Bohemian . .	*	·49	9·3	20·4	9·8	60·5	29·7	30·2	69·8	—
Zwickau . . .	E	·79	12·2	15·9	14·9	57·0	28·1	30·8	69·2	1340
English . . .	O	·52	9·2	18·9	9·8	62·1	28·1	28·7	71·1	1470
Westphalian. .	K	·53	9·3	20·6	10·6	59·5	29·9	31·2	68·8	1330
Oberschleswig .	I	·71	9·0	18·4	12·9	59·7	27·4	31·3	68·7	—

* Taken from generator at the Munich Gas-Works.

On comparison of the figures given in Tables I. and II., it will be found that the different kinds of coke, under similar conditions, give gases of nearly the same composition, whether the draught be slow or quick. Considerable deviations are attributable to changes in the generator or the draught.

Table III. gives the composition of gases from the various kinds of coke in the grate-generator, with unequal quantities of steam. As the steam varies, so does the CO_2, CO, and H; yet, on the whole, the respective quantities of combustible gases and carbon gases are about equal.

Now, taking the average percentages as follows:—

I.—Slit-generator, slow draught, $CO_2 = 1·9$; $CO = 28·3$; temp., 930°.

II.—Slit-generator, strong draught, $CO_2 = 5·8$; $CO = 22·6$; temp., 1830°.

III.—Grate-generator, steam = 6·3; carbon gases = 28·8; combustible gases = 30·6; temp., 1300°.

The quantity of carbon necessary for producing a cubic mètre of the heating gas is found by multiplying the percentage of $CO_2 + CO$ by 0·5363 ÷ 100, which gives, therefore—

I. = 0·1615 kilo.; II. = 0·1523 kilo.; III. = 0·1542 kilo.

If no heat were lost, there should be in one cubic mètre of the gases exactly the same amount of heat, as temperature or in the form of combustible gas, as would be produced by the combustion of the above weights of carbon, viz.—

I. = 0·1615 × 8080 = 1304 units; II. = 1230 units; III. = 1245 units.

Then, taking the amount of heat actually present in the gas as it leaves the generator, and adding it to the above, we find that the total theoretic value of these three gases is, as might be expected, higher than that which is practically available, the loss per cent. being for—

I. = 23·2; II. = 19·7; III. = 13·8.

The loss is caused partly in melting the clinker, partly through the bars, and partly through the walls of the furnace. These sources of loss are not increased by high draughts, as the CO thereby lost is completely compensated for by the heightened temperature. Less heat is lost by a grate than by a slit generator, and if the heat necessary to evaporate the steam be the waste heat of the flues, as at Munich, 91 per cent. of the heat of the gasified carbon is realizable. A peculiarity of these values for the loss, determined as they have been by special experiment, lies in the fact that they are decidedly unfavourable in comparison with the ordinary course of working—at Munich, for example. Thus it may be said that, while the general impression respecting experimental results is, that they are too good to be depended on in every-day practice, in this case the contrary obtains, and the results may be safely taken as decidedly below the level of normal working.

A DISTRIBUTOR.

By Mr. J. O. N. RUTTER.

It may not be possible to understand or exactly describe the ways in which gas comports itself when drawn or driven through pipes. It is to be expected that there are differences dependent on quick and slow rates of motion, and differences in relation to pipes of small and large areas. In distributing gas from the holders, the out-flow is tranquil, or if at the outlets on the works there be at times a sensible oscillatory movement, it soon subsides.

Many years before (rotary) exhausters were invented, and, more remotely, when bye-pass valves were not much used, I had noticed that (crude) gas, in passing out of the end of a pipe at a distance of 30 yards from the hydraulic, had an undulatory, or, more correctly, a pulsatory motion. Whether by exhaustion or propulsion, this motion is probably the normal condition of its on-flow whilst passing the various kinds of apparatus in its nascent state. It is only partly subdued when passing the purifiers.

There is another phase of the on-flow of gas in pipes which merits attention. It is the continuity of the volume with scarcely any interchange as between its exterior and interior. Whatever be the area of the conduit, the column or stream seems to pass on, and on, and on, without much disturbance. No doubt the twistings and turnings, in passing valves and bends and elbows, cause a little interchange; but there is reason to believe there is never a thorough change of places. Here is one means of explaining the comparative inefficiency—the slowness in cooling power—of ordinarily constructed condensers.

A condenser ought to be of sufficient capacity to be considerably in advance of the work it will have to do. In other words, the so-called condensing apparatus should be adapted for more than the greatest quantity of gas estimated to be required to pass through it. All other arrangements being proportionate, there is then not likely to be any special difficulties in keeping down temperature. The conditions most favourable are when the column of gas moves slowly. Not so when things are reversed. With a high rate of speed there is not sufficient time for the gas to part with its heat.

Let me say a few words about what are called condensers. To me it appears desirable that for this important part of gas apparatus a name should be adopted significant of its use, and respecting which there might be some sort of unanimity. Whatever be the specialities of conformation, the design of a condenser is not to *condense* gas, but some of the vaporous products of the distillatory process which are mixed with it. This part of its work is, therefore, supplementary, not primary. Would not *refrigerator* be a more appropriate name?*

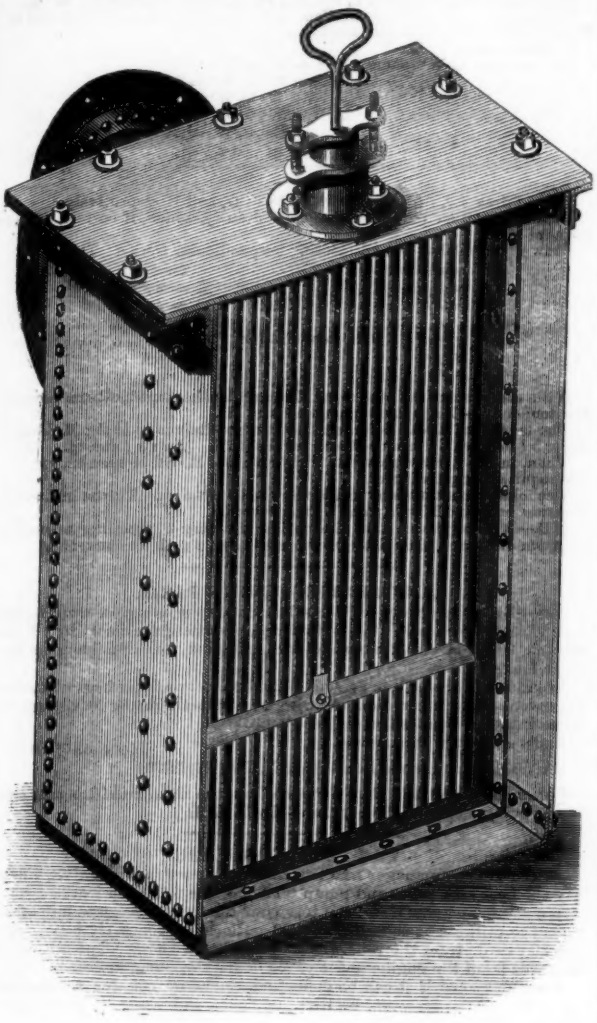
For a long period I have pondered over the various difficulties in gas-making, especially the best means of gradually cooling the newly-produced gas before entering the purifiers; and also of keeping the works comparatively clear from naphthaline.

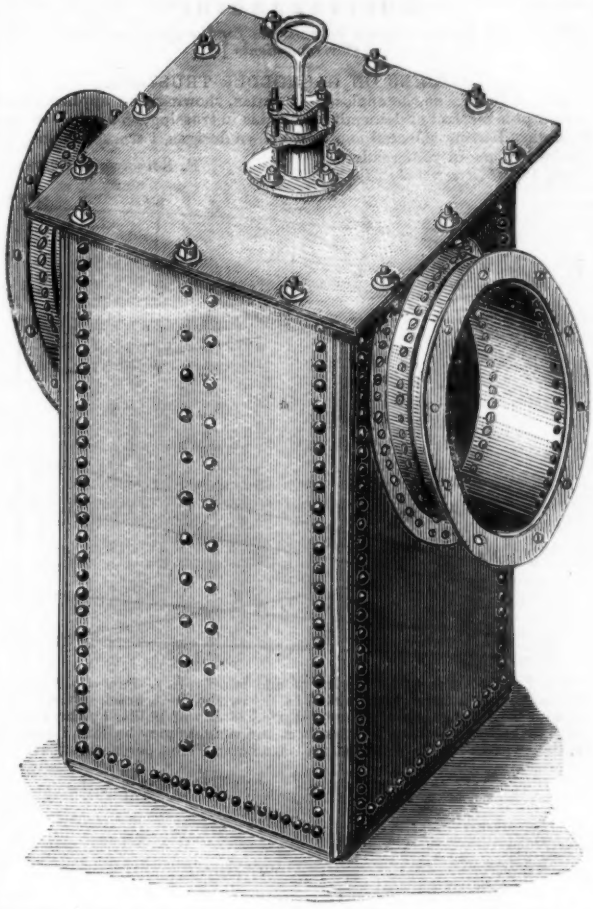
In 1878 it was decided to extend the refrigeratory parts of the plant at Black Rock, by fixing between the outlets of the hydraulics and the inlets of the refrigerators (called condensers) about 150 yards of ($\frac{1}{4}$-inch plate) 18-inch main. Before ordering the main, in thinking of what it would have to do, and how it could be made to perform its duties most perfectly, and knowing a good deal of the discouragements attendant upon existing arrangements, I determined to adopt a plan for breaking up—*distributing*—the current of gas. In this I have succeeded. Instead of allowing the on-flow to be continuous, the current is divided by compelling it to pass between the bars of gratings. The gratings are placed in suitably fitted-up boxes, connected at convenient distances with, and constituting parts of the main. Thus it might be inferred that so much commotion is caused, and such frequent interchanges occur, that the heat is more quickly dispersed.

It was natural to expect, and to reckon upon some good results from the perturbations caused by the gratings. The actual results are greatly in excess of my expectations.

The 18-inch main is fixed against the insides of the walls of the

* A *cooler* does not seem to be exactly the right name for a series of pipes. By that term we think of open vats or shallow tanks, as in breweries, distilleries, dye works, chemical works, &c., &c.





retort-houses, at the sides, but at one (N.) end, of necessity, outside. This latter part is protected from the weather and extremes of temperature. What have been the results? During the coldest periods of the past winter, at the outlet of the hydraulics, temperatures have ranged from 140° to 132°. After passing through the 18-inch main, temperatures have ranged from 102° to 92°. The variations from day to day and night to night were less than might have been expected. During the first week of July, 1879, with fewer retorts in action and one-third the quantity of gas passing, temperatures at the hydraulics have ranged from 131° to 124°, and at the outlet of the 18-inch main from 90° to 74°. With an initial temperature ranging between 50° and 40° less than formerly, it is not difficult to believe that there were benefits accruing in all the subsequent stages; the workings of refrigerators, washer, scrubbers, and purifiers being at much lower temperatures.

What about naphthaline? There has not been, since the 18-inch main has been in action, one-eighth the quantity as during corresponding periods in the last ten years.

In gas-making, some of the practical effects of radiation are understood and realized; but its laws seem not to be specially regarded. It may be justly concluded that the rate of radiation is slower or faster in proportion to differences of temperature inside and outside a pipe through which gas passes, and the thinness or thickness of the metal. Whether pipes be arranged vertically or horizontally for the purpose of accelerating the transmission of heat from inside to outside, there has not been sufficient care to provide against recurring variations. Some of these are sudden in their influence, and subversive of the proper operation of the apparatus.

The variations referred to are consequent upon sunshine and cloudiness, differences of temperature by day and night, successions of seasons, and the quantities of gas produced; any one of which is an important factor. Hence, therefore, what might appropriately be called the refrigerative part of the process of gas-making is frequently the most defective. It never has been, and is not now constant in its action, being subjected to changes from meteorological phenomena and the quantities of gas required at different periods. If gas-making is to hold a place among the sciences, there need be more science infused into some parts of its processes.

How can the refrigeration of gas be accomplished whilst the present system is pursued? "Rule-of-thumb" and "hit-or-miss" are much easier, and, in most instances, less expensive than exact science. We ought not to permit in ourselves that which we disapprove in others. Why should not the preparatory processes, in their various forms of apparatus, be conducted under shelter from *direct* atmospherical influences? Such arrangements would surely facilitate a greater degree of control in the successive operations from retorts to holders, and help to give something like uniformity, notwithstanding meteorological and seasonal changes. This is required. The cost is not worth consideration if that can thereby be acquired which hitherto has never been attainable.

Great as may be the advantages of the distributors, it is to be expected that some of the refrigerative effects will be due to differences of areas—18 inch as compared with 12 inch—and also thickness of metal, ¼-inch (wrought) as compared with ⅝-inch (cast). Making allowance for this, I know I am right in saying that by separating and disturbing at intervals the on-flowing current of gas, the refrigerative effects are chiefly promoted. Be this as it may, there is satisfaction in having something which points in the right direction. Both combined—that is, a divided column and low rate of speed—are probably as near the right method as can be practically adopted.* It should also be noted that a greater reduction in temperatures might have been obtained if the main at the sides of retort-houses had been fixed outside instead of inside. This was not desirable; gradual and moderate, not sudden and extreme differences in temperatures being kept in view.

By referring to the drawings, not many words are required for describing the distributor—one (as adapted for an 18-inch main) showing it in its complete form, the other with an end removed. It consists of a rectangular box of ¼-inch plate; length 2 ft., width 2 ft. 2 in., height 3 ft. 6 in. The grating is ½-inch rod, and the spaces between ½-inch, fixed in a frame which is rivetted to the sides of the box. The space below the level of the main is a chamber (1 ft. 4 in. deep) for receiving thick tar, which by a 2-inch cock is drawn off daily, or less frequently. To the chamber a steam-pipe is fitted for liquefying the tar in cold weather.

The bowed rod passing through the stuffing-box is for working a scraper fixed in grooves at the sides. The scraper surrounds the rods, and is intended to keep them clear from tar which may be projected against and adhere to them.

When further extensions of plant are required at Black Rock, especially in the management of gas in its earliest stages of manufacture, what would be the most effective means for refrigeration? Would it be some new form of a so-called condenser? I think not. My recommendation would be a 24-inch (¼-in. plate) main fixed above the present 18-inch, and with six, instead of three distributors in the 150 yards, and, for greater effect in distributing the on-flowing current of gas, the gratings in each alternate box might be fixed horizontally.

Black Rock, Brighton, July 22, 1879.

* As an illustration of the motion of gas in pipes of different areas, let it be supposed that the make of gas is at the rate of 60,000 cubic feet per hour. At a rough estimate, the rate of speed, in miles per hour, in each of the following sized mains will be—12-inch = 14·47; 18-inch = 6·43; 24-inch = 3·62.

Correspondence.

[We do not hold ourselves responsible for the opinions expressed by Correspondents.]

STRAINS ON GASHOLDER TRUSSING.

SIR,—I have sent the enclosed diagrams, showing the application of the graphic method of determining strains in trussing, as applied to gasholders. Having selected two well-known designs, I trust they may be useful to some of your readers.

F. SOUTHWELL CRIPPS.

30, *Pigott Street, July* 23, 1879.

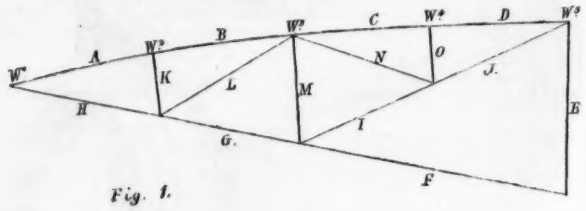


Fig. 1.

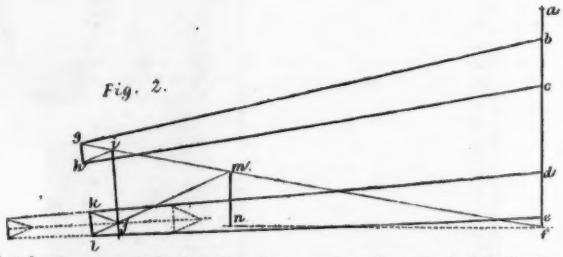


Fig. 2.

Let fig. 1 represent the trussing of one main rafter. Part of the load on the secondary rafter is transmitted to W³ by the main bracket bars. Then to find W¹, W², &c., divide the total area of top of holder by the number of main rafters. Calling the result x, the weights may be found approximately as follows, the assumed pressure being 35 lbs. per square foot:—

$$W^1 = \frac{x}{580} \text{ tons.} \qquad W^3 = \frac{x}{170} \text{ tons.}$$

$$W^2 = \frac{x}{280} \text{ ,,} \qquad W^4 = \frac{x}{280} \text{ ,,}$$

$$W^5 = \frac{x}{2280} \text{ tons.}$$

Now, referring to fig. 2, mark off on the vertical line, $a\,f$, to any convenient scale, the distances $a\,b$, $b\,c$, &c. = to the weights W¹, W², &c.

Draw $b\,g$, $c\,h$, $d\,k$, and $e\,l$ parallel to A, B, C, and D in fig. 1, but of indefinite length.

Draw $f\,q$ parallel to H.
,, $g\,h$,, K.
,, $h\,i$,, L.
,, $i\,j$,, M.

To find length of $i\,j$, proceed thus:—Draw two parallels to O, one on each side of $i\,j$, upon which construct similar triangles, having their sides parallel to O, N, and J respectively, as shown by dotted lines. Join their apices, and where this line cuts $i\,j$ determines the point j.

Through j draw the parallels $j\,k$ and $j\,l$. Join $k\,l$, which will be parallel to O. Produce $l\,j$ to m. This line is parallel to I. Draw $m\,n$ parallel to E, cutting perpendicular from f.

The strains may be now scaled off the diagram as follows:—

Compression in		Tension in
A = $b\,g$ tons.		F = $m\,f$ tons.
B = $c\,h$,,		G = $i\,j$,,
C = $d\,k$,,		H = $g\,f$,,
D = $e\,l$,,		I = $j\,m$,,
E = $m\,n$,,	due to one rafter.	J = $l\,m$,,
K = $g\,h$,,		L = $h\,i$,,
M = $i\,j$,,		N = $k\,j$,,
O = $k\,l$,,		

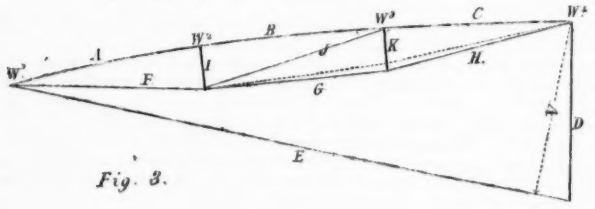


Fig. 3.

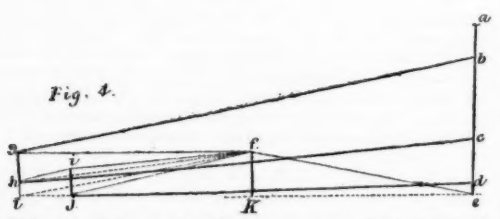


Fig. 4.

The next design, fig. 3, is one in which there are no short rafters, the weight being distributed as follows:—

Total area of top, divided by number of rafters, = x. Then

$$W^1 = \frac{x}{221} \text{ tons.} \qquad W^3 = \frac{x}{277} \text{ tons.}$$

$$W^2 = \frac{x}{144} \text{ ,,} \qquad W^4 = \frac{x}{1750} \text{ ,,}$$

Referring to fig. 4, make $a\,b$, $b\,c$, &c., equal to the weights W¹, W², &c. Through b, c, and d draw parallels to A, B, and C. Draw $e\,f$ parallel to E, and make $e\,f$ equal to the tension in E.

To find tension in E,

Let reaction at W¹ (namely, W² + W³ + W⁴) = R.
Distance from W¹ to W⁴ = S.
,, W² to W⁴ = T.
,, W³ to W⁴ = U.
,, E to W⁴ = V.

$$ef = \frac{R \times S - (W^2 \times T + W^3 \times U)}{V}$$

From f draw $f\,g$, $f\,i$, and $f\,j$ parallel to F, G, and H respectively.

Draw $g\,h$ and $h\,i$ parallel to I and J. Join $i\,j$, which, if correct, will be parallel to K.

Draw $f\,k$ parallel to D, and meeting perpendicular from e. Then the

Compression in		Tension in
A = $b\,g$ tons.		E = $e\,f$ tons.
B = $c\,h$,,		F = $f\,g$,,
C = $d\,j$,,		G = $f\,i$,,
D = $f\,k$,,	due to one rafter.	H = $f\,j$,,
I = $g\,h$,,		J = $h\,i$,,
K = $i\,j$,,		

If the rod J is omitted, the strut K should be shortened, otherwise there is a tendency to bulge the top outwards at W³.

The length of K can be determined thus:—Referring to fig. 4, from h draw $h\,l$ to meet $d\,j$ produced and parallel to K. Join $h\,f$ and $l\,f$.

Then, in fig. 3, draw parallels to $h\,f$ and $l\,f$. It will be seen they cut the required length of strut.

The following alterations will be made in the strains:—Thrust in K = $h\,l$. Tension in G and H = $h\,f$ and $l\,f$ respectively.

N.B.—It is advisable that the outline drawing of trussing, as well as diagram of strains, should be drawn to as large a scale as convenient.

ELECTRIC LIGHTING IN PARIS.

SIR,—Being by chance in Paris last Sunday evening, in a *café* facing the Théâtre Français; I was astonished, about eight o'clock, by all the electric lamps in the open space there going out, and remaining out for some four minutes.

From this accident it is evident that the electric light has to be much improved before it can compete with such street lighting by coal gas as there is in the Rue du Quatre Septembre.

Facts speak for themselves.

HODGSON JONES.

Château d'Eau, Arras, Pas de Calais, July 23, 1879.

[An accident of this kind happened on the 26th and 27th ult., four lamps going out on each occasion.—ED. J. G. L.]

THE PUMPING OF TAR.

SIR,—Will any manager who has had experience in the matter kindly say the best size pipes and pump for doing the following work?

We want to know if we can force our tar from the works into tanks upon the railway, at the rate of 2000 gallons in about six hours. We are 200 yards from the rails, and 26 yards below them. The tar-well is 20 yards from the engine and 4 yards below the pump-house.

I am not sure if it can be done, and therefore ask for information upon the matter from my brother managers, and shall be grateful for any help they will render me.

B. A. T.

July 24, 1879.

WARRINGTON CORPORATION GAS SUPPLY.—The accounts of the gas department of the Corporation of Warrington, for the nine months ending March 25 last, show that the total receipts were £27,379 9s. 6d., of which sum £19,360 19s. 2d. was derived from gas sales and meter rents, £8844 5s. 11d. from fittings, £1126 3s. 8d. from coke, £1324 14s. 4d. from tar, £901 16s. 8d. from ammonia, and the remainder from lime, cottage rents, stock in hand, &c. The expenditure was £17,204 1s. 1d., of which £1649 11s. 4d. was for wages for gas manufacture; salaries, £754 19s. 6d.; cannel and coal, £5993 5s. 7d.; rates and taxes, £1517 7s. 10d.; lamp-lighting, £342 5s. 9d.; fittings, £819 15s.; annuities and interest on loans, £3173 2s. 6d., besides other items. After making all allowances for discounts, a balance of £5784 17s. 10d. remains; and, deducting from this the sum of £1580 for three months annuities and interest, a net profit is left of £4204 17s. 10d. on the transactions of the Gas Committee. The quantity of gas made during the nine months was 110,881,000 cubic feet, and the quantity of coal and cannel carbonized was 11,307 tons 18 cwt. The quantity of gas sold and used was 97,328,070 cubic feet, loss by leakage 13,552,930 cubic feet, being 12·22 per cent. of the gas made. Make of gas per ton of fuel 9804 cubic feet. We shall take an early opportunity of referring to these accounts more in detail.

DUMFRIES COMMISSIONERS GAS-WORKS.—A short paragraph appeared in last week's "Trade Notes from Scotland," in reference to the first annual statement of accounts of the gas supply undertaking of Dumfries, and the following particulars will be of interest:—The gas-works, it may be remembered, were purchased by the burgh more than a year ago, under the provisions of the Burghs Gas Supply (Scotland) Act. The capital of the Commission consisted of a loan of £25,000, at 4½ per cent., of which loan £685 was paid off during last year. The expenditure consisted of £21,000 paid for the works and plant; £1194 19s. 7d. for arbitration, conveyance, and loan; £187 10s. for new plant, &c.; £571 3s. 4d. for new main and service pipes; £133 9s. 6d. for new meters—leaving a balance of £1972 17s. 7d. The revenue account shows that the manufacture of gas cost £6288 15s. 2d.; distribution, £830 6s. 2d.; management, £307 15s. 2d.; taxes, &c., £70 17s. 11d.; and charges and bad debts, £84 12s. 2d.—the total being £7582 6s. 7d. Against this there was an income of £5976 17s. 6d. for the sale of 20,492,143 cubic feet of gas at 5s. 10d. per 1000 feet, £228 6s. 11d. at 5s. per 1000, £362 9s. 10d. at 4s. 4d. per 1000, £39 at 5s. per 1000, and £504 10s. 9d. at 5s. 10d. per 1000 (the two latter being for public lighting, and the lower items being under contracts with private parties, which will now be illegal); £244 4s. 10d. for coke; £678 16s. 6d. for tar, &c.; £68 14s. 6d. for refuse lime; and £36 11s. 4d. by rents, &c.—total, £8254 9s. 10d. The interest paid was £1071 2s. 1d., and amount paid to sinking-fund for redemption of mortgage loan, £625, giving a net loss on the year's transactions of £1006 7s. 7d. This loss is accounted for by the production of gas per ton of best coal having been only 5300 feet, as shown by consumers meters, instead of at least 8000 feet; but new retorts and new pipes having been obtained, and the strictest attention paid by the Committee, it appears, according to a new station-meter procured, that results are now as high as 9500 and even 11,000 feet per ton, so that next year, it is hoped, a considerable profit will be made.

Parliamentary Intelligence.

HOUSE OF LORDS.

MONDAY, JULY 21.

The following Bills received the Royal Assent by Commission:—Arlecdon and Frizington Water, Belfast Water, Birmingham Gas, Cardiff Corporation, Gas and Water Provisional Orders Confirmation, Lancaster Gas, Mirfield Gas, Morecambe Gas, Newcastle-upon-Tyne and Gateshead Gas, Plymouth and Stonehouse Gas, Preston Gas, Queenstown Gas, South Shields Gas, Wisbech Gas.

Liverpool Lighting Bill,—reported, with amendments.

TUESDAY, JULY 22.

Blackpool Extension and Improvement Bill, Leicester Corporation Bill,—read the third time, with the amendments, and passed.

THURSDAY, JULY 24.

The following Bills received the Royal Assent by Commission:—Alliance and Dublin Consumers Gas, Rotherham Borough.

Nottingham Corporation Bill,—read the third time, with the amendments, and passed.

HOUSE OF COMMONS.

MONDAY, JULY 22.

Water Supply (Metropolis).—A petition for inquiring into the water supply of the Metropolis was presented from the Vestry of St. George-the-Martyr.

HOUSE OF LORDS COMMITTEE.

MONDAY, JULY 21.

(*Before Earl* SPENCER, *Chairman; Earl* DUNDONALD, *Lord* SOMERTON, *Lord* WAVENEY, *and Lord* NORTON.)

LIVERPOOL LIGHTING BILL.

Mr. POPE, Q.C., and Mr. PEMBER, Q.C., appeared for the promoters; and Mr. MICHAEL, Q.C., Mr. ASPINALL, Q.C., and Mr. BIDDER, Q.C., for the Liverpool United Gaslight Company, petitioners against the Bill.

Mr. POPE, in opening the case for the promoters, said that the Bill proposed, among other things, to authorize and empower the Corporation of Liverpool to manufacture and provide, and exclusively to supply, light by means of electricity within the borough of Liverpool, and also to provide and supply heat or motive power by application of the electricity by which they produced or supplied light. The time limited was five years, and it was sought to borrow £50,000 for the purpose of the experiment, the lighting to be confined to places of public resort. The petition of the Liverpool United Gaslight Company stated that previously and up to the year 1848, light for public and private purposes had been supplied within the borough and the townships adjacent thereto by two separate and independent Gas Companies, which were then amalgamated and consolidated, and the concern became vested in the petitioners, who were the only company authorized to break up the streets and lay pipes for the supply of gas or for the purpose of lighting in Liverpool. That was the only monopoly they enjoyed, and the customers could please themselves. Among other things, the petitioners were required to light the public lamps within the borough, and the quality and the price of gas to be supplied were prescribed by the Act. If they were called upon by the Corporation to do so, they were bound to light at such times as might be agreed upon, and there was no arbitration. It was a pure question of agreement, and they did not propose to interfere with their rights and liabilities, but they simply proposed to do that which they had a right to do. They did not wish to be the sole suppliers of the electric light; and if any other company chose to supply it they could do so. If the experiments were allowed it would be an enormous advantage in the public interest. The Bill was of the simplest character, and he asked the Committee to decide that the petitioners had no *locus standi* to be heard.

Mr. MICHAEL urged that if the Bill passed it would act in a detrimental way to the Shareholders of the Gas Company, and tend to enable the Corporation to acquire the property of the Gas Company at an inadequate price. It was contrary to the spirit of the provisions of the Municipal Corporations (Borough Funds) Act, 1872; and, if passed, would lead to undue and unfair competition, and be inexpedient and contrary to the policy of Parliament. The undertaking was of an entirely novel and experimental character, and of doubtful utility and practicability, and would necessitate much additional breaking up of the streets. It would likewise interfere with the traffic along the road, and with the mains and pipes of the petitioners, and would cause inconvenience and expense to the public, and also loss to them. The promoters sought to go beyond the law; and he contended that his clients were strictly in order in insisting upon *locus standi*, especially as there would of necessity be a great deterioration of their property. The sole motive was, by some means or other, to injure the Gas Company, and so acquire a power which had never previously been granted; consequently they had a right to be heard, to see how far their property would be injured.

Mr. POPE contended that the Bill did not interfere with any of the rights or property of the petitioners, and therefore they had no *locus standi*. They had no property or vested right in lighting a theatre or a railway station. The truth was that they did not interfere any more with any property than was the case in any question of improvement. If they were afraid of the result, that must not give them a *locus standi*. Every ratepayer in the community was bound by the act of a representative body, and the Gas Company had no more right to object to the act of the Corporation than any other individual ratepayer had. If, however, their lordships thought that it was intended to interfere with the rights of the Compeny, then by the statutory enactments the Gas Company had the right to *locus standi*.

The committee-room was then cleared. After consulting together for a few minutes, the public were re-admitted, when

The CHAIRMAN said the Committee admitted the *locus standi* of the petitioners.

Dr. *C. W. Siemens*, examined by Mr. PEMBER.

I know the open spaces in Liverpool, which are very well situated for making the experiments suggested by the promoters of this Bill. Those experiments would show the comparative advantages of the electric system, as compared with the gas system, and also the comparative cost. As a principle, the electric light has been proved; but it has not as yet been proved as a practical mode of illumination, which could only be done by a lengthy trial, conducted with all the guarantees necessary to make it a fair one. My view is that the electric light should be placed differently from gas, in order to distribute it from each centre over a larger area. Gaslight is of a certain intensity, and, therefore, should be placed at a greater distance from the place to be illuminated than oil; and for the same reason electric light should be placed at a greater distance from the surface to be illuminated. It therefore requires investigation and study of how the electric light should be distributed in the case of a public place or street, and also in the case of a hall or railway station, in order to distribute the light with advantage as to cost, and also in such a way as to be agreeable to the public, who are to benefit by it. The sites we propose to light are particularly advantageous for trying the electric light under those different circumstances. I think it would take a period of five years in order to establish the question upon practical grounds, especially when the dynamics of the science of electricity are proceeding at the pace they are now doing.

Cross-examined by Mr. BIDDER: The experiments on the Thames Embankment are limited to one apparatus; but it is probable that, in carrying out experiments by an independent body like the Liverpool Corporation, they will be carried out without regard to any particular apparatus or mode of lighting. The question of electric lighting is a very large one, and will never be decided in one or two places. It should be tried in a great many places, and under the most advantageous circumstances. It will, of course, try the question of lighting a large space; if carried to a theatre, it would establish the question of cost, and also its sanitary advantages; and, if the railway station is lighted, it will settle the question whether that can be done with advantage.

Mr. BIDDER: If it is really meant simply as a *bonâ fide* experiment, what is to prevent it being done now without any Bill, so far as the mere experiment is concerned?

Witness: The mere experiment will not decide the practical question—viz., the expense.

Why? Have not the Metropolitan Board of Works, in their experiments on the Embankment, and the City Authorities in their experiments on the Holborn Viaduct, been making very careful observations and calculations, and obtaining very carefully analyzed results as to the cost of lighting?—Yes, and the result has been somewhat unfavourable to the electric light; but whereas, on the other hand, it can be shown that the electric light *per se* is much cheaper than gaslight *per se*, therefore a great deal has yet to be done in order to harmonize those two contradictory results.

Are experiments any the less trustworthy because they are not carried on under an Act of Parliament? For instance, if the Corporation of Liverpool choose to light up St. George's Hall, what is to prevent them doing it without any Bill at all?—The disadvantage would be, that in lighting St. George's Hall it would be a limited experiment; whereas, in order to test the commercial question, the experiment should be tried upon a larger scale.

Supposing it is thought that the experiment would be on too limited a scale in St. George's Hall taken by itself, what is to prevent their extending the experiment, and lighting all the streets round about it at the present moment?—I hear that they require an Act of Parliament in order to raise funds.

Cross-examination continued: I am not aware that any authority is needed for carrying the wires through the air, and I do not know of any reason why it should be more difficult to do so in Liverpool than in London. No doubt theatres, railway stations, hotels, and other places of public resort, are important customers of the Gas Company.

Mr. BIDDER: As a commercial man, what do you think would be the effect upon the value of the Gas Company's shares, of a Bill authorizing the Corporation to compete with them in the lighting of those places?

Witness: They would lose those particular customers; but, on the other hand, they would gain enormously through the fact that the public would get accustomed to more intense light, and the total consumption of gas would not be diminished. There are also many other applications for gas—for instance, in the working of gas-engines, and in order to produce the electric light, and for heating purposes, and so forth. For the moment it would, I have no doubt, tend to depreciate the value of the shares; but I do not think that would be the result in the long run.

Let us go a step further. At the time that it depreciated the value of the Company's shares, it would enable the Corporation to negotiate for the purchase of the Company on better terms, would it not?—If the Gas Company were to give way from fear, or panic, or anything else——

If the market value of their shares were reduced, any negotiation for the purchase of those shares would proceed with reference to their market value, would it not?—As I understand the question, it is only one of experimenting, and surely it is the interest of the public, and of every one, to ascertain the truth.

Are you aware that the quality of the gas supplied in Liverpool is 20 candles, and do you think that is an economical sort of fuel to use with the dynamo-electric machine?—Yes, experiments have shown that more light is obtained by burning gas in an engine than in consuming it in burners direct. Gas of a high illuminating power will give a greater heating result than that of a lower power; it will give more heat as well as light.

The Bill proposes to authorize the Corporation to let out dynamo-electric machines. What is to prevent their doing that at the present time?—The breaking up of the streets, I suppose.

But surely you do not want to break up the streets to let a man have a dynamo-electric machine on his own premises?—Yes; if you let out the power you have to work the machine at a central station, in order to lead the electric current to the place where the power is to be utilized.

I thought the more economical way to do it, electrically speaking, is to provide him with a gas-engine to work his own dynamo-electric machine?—Certainly, in that case he can do it himself.

Or the Corporation can do it for him?—Only he would have to use the light to a considerable extent, or else he would subdivide it again to such an extent as to make it unprofitable.

It is one of the features of this Bill that the Corporation propose to raise £50,000, in order to try this experiment; but there are plenty of companies at the present time who are only too ready to undertake electric experiments, are there not?—Those companies advocate particular apparatus—some one kind and some another; but the Corporation wish to be quite independent of any particular description, and they wish to try it on a large scale.

Re-examined by Mr. PEMBER: The very essence of the experiment which the Corporation wish to make, is the establishment of a central motive power at St. George's Hall, and the distribution from thence to the theatre, to the hotels, to the Free Library, or to the Picton Reading-Room. There is already a steam-engine at St. George's Hall, which is available for the purpose. I believe all the experiments which have been made in London have been conducted separately and in isolation—that is to say, the lighting on the Thames Embankment has been disconnected with the lighting on Holborn Viaduct. We want a combined experiment on a large scale extending over several years. I believe the Jablochkoff light is the only one that has been tried in the public streets.

Mr. PEMBER: It would not do for the Corporation to have, first of all, to hand over their site to a company to try one thing, and then to have to remove that apparatus, and try another; it is much better for them to be upon the spot themselves, and make any experiment they may be advised to try?

Witness: In order to try the experiment fairly and independently, it is an essential condition.

Mr. *A. Bower*, examined by Mr. WRIGHT.

I am a member of the Liverpool Town Council, which body, last autumn, caused a report to be made by their Engineer, upon the system of electric lighting then in use in Paris, and since that time they have taken great pains to inform themselves of the condition in which the question now stands. So far as the scientific possibility of the light is concerned, the view of the Corporation is, that it is already fairly established; but they also wish to show that it can be made commercially successful. I should consider that the Gas Company have no appliances to try experiments with, and their interests are decidedly against the electric light. If they wished to do so, they would require parliamentary powers for the purpose. As regards health, the effect of the electric light is that it practically consumes none of the oxygen in the air, whereas each gas-burner consumes approximately about three times as much as an individual. The effect of this Bill will simply be that at the end of five years, so far as the Gas Company are concerned, the question will be left entirely open, to be dealt with on its merits as between the Company and the Corporation. With regard to the question of breaking up the streets, it would be necessary to do that, because we do not wish to confine ourselves to any one system of electric lighting. There are different systems of lighting. There is a series of lamps comparatively near one another; then there is a concentrated light, each light being placed at an immense distance apart from another. In certain cases, it might be possible to carry the whole light without breaking up the ground, where they had a comparatively small number of lights near one another; but it would become an absolute practical impossibility to do it where there are large concentrated lights at great distances, and, therefore, it is compulsory to break up the ground. Supposing you were to cross the street to the North-Western Railway, it would be compulsory to go underground. Because we apply for power to raise £50,000, we do not of necessity undertake to spend it.

Cross-examined by Mr. ASPINALL: When the Bill was first introduced, it contained powers to buy up the Gas Company.

Mr. ASPINALL: Did it not also contain power to light the whole of Liverpool for commercial purposes in the ordinary way?

Witness: I believe the clause was more general in the first instance.

At all events, was it not your object, as a Corporation, to obtain powers of lighting Liverpool by the electric light in the hands of the Corporation, without asking the consent of the Gas Company, or without their assistance?—The intention was to see whether it would be commercially successful, and then, of course, with a wide Bill, I suppose it could be carried further.

Did you not, at all events, seek for power to take the control of the whole lighting of Liverpool by electricity into your own hands?—I think so, decidedly.

And it was only in the House of Commons that the Bill was cut down to an experimental one. Do you not know that if you obtained this Bill, it would give you a large vantage-ground in any contest between you and the Gas Company, at the end of five years, for power to light Liverpool by electricity?—I should suppose it would give the town an advantage in lighting by electricity; but the object of our Bill is to see whether the system is worth carrying out.

In your opinion, as a scientific man, why would not the site of St. George's Hall, and the buildings which belong to yourselves opposite to that hall, be enough for you?—For several reasons. In the first place, it might just as well be suggested that a gas company could equally well make gas on all the different premises, rather than in their own central station; and then, beyond that, if we simply limited our experiments to our own premises, we should have no means of judging whether the public liked it, and we should have no means of ascertaining what they would pay for it, and in no way should we test the commercial value of it. The public will take anything you give them for nothing, and any experiment we carried out in buildings belonging to the Corporation would be so given; but there would be no testing the commercial advantages there, and it is only when we get into buildings outside our own property that we test it.

There is a clause in the Bill to prevent you selling at a profit, but nothing to prevent you selling at a loss; so that it would be in the power of the Corporation to possess themselves of all the customers of the Gas Company which are mentioned in the Bill as occupiers of places of public resort, either at a loss or for nothing?—I suppose it would, if the Corporation were foolish enough to do it.

You purpose to supply any places of public resort which the Local Government Board may, from time to time, approve, so that, if you went to that Board, and said it would assist your experiment to light all the large shops in Liverpool, that would be within your contention, would it not?—We exclude shops in the first instance.

I do not know whether you exclude them in the first instance, but how do you exclude them now?—Under that clause, if the Local Government Board sanction it.

Not only shops, but churches and chapels of every description. Do you contemplate having all those places, if you find it convenient?—Certainly not.

There is nothing in the Bill to prevent it?—Yes, there is; the Local Government Board.

But the Local Government Board, supposing this Bill should be passed, without any further application to Parliament, are to have power to give you permission to light anything which comes within the meaning of the words "public resort," and I suppose you do not doubt that a church is such a place. Are those the places that are now supplied by the Gas Company with light?—Yes, they are.

You know the circumstances of Liverpool very well; have you any doubt that the taking of compulsory powers to light at any price—for nothing, if you like—without consulting the Gas Company, all the premises of the Mersey Dock and Harbour Board, if they ask you, and all the railway stations, public slaughter-houses, and theatres, and, in a still more indefinable manner, anything whatever which might be called a "place of public resort," which the Local Government Board may approve on any representation of yours, that it would be a most serious injury to the property of the Gas Company?—You are supposing an impossibility. We take no power to do that. We simply ask for power to supply without profit, which means that we will supply the light for what it costs us.

That means that you would supply at a price at which no trader could do, because no trading company could supply without a profit?—That does not at all follow, for the simple reason that we are going to make an experiment, which, after all, is a limited one, and the cost of which would be much greater than if we carried out a large systematic lighting of the town, which might be without profit; but out of which the Corporation might make a large profit ultimately by the operation.

You say the time is limited to five years; but would not the effect be serious upon the property of the Gas Company?—If it was a great success it would ultimately.

Then do you not think that your having the power to do it is a serious matter for the Gas Company?—No; I do not.

Re-examined by Mr. PEMBER: If the experiment is a failure, there will be no effect upon the Gas Company; but if it is a success, it would probably lead to a supercession of gas, to a great extent, by the electric light. The £50,000 we ask for must cover the cost of all the apparatus required. At the present moment, the Mersey Dock Board could use the electric light over the whole of their area, extending to upwards of seven miles, if they chose. As to giving the light without profit, we should go no farther than was absolutely necessary to try the experiment. If we applied to the Local Government Board for permission to try the light upon a place of public resort, we should have to show good reason for wishing to make the experiment. If there were a sale of the Gas Company's property, and the value had to be ascertained, the arbitrator would take into consideration the three or four years during which we had been making experiments, which would be exceptional years, in consequence of the loss of custom involved by our operations. Without the theatre and the railway station we could not try the experiment commercially; but having those two customers, they could tell at the end of five years what they considered to be the value of the light we offered; otherwise the experiment would be entirely nullified.

Mr. *George F. Deacon*, examined by Mr. PEMBER.

I am Engineer to the Borough of Liverpool, and Local Inspector of Gas Lighting. Last year I made myself acquainted with the experiments that were made in Paris for lighting certain streets and places by electricity. So far as the effect produced was concerned, the result was very favourable to the electric light, as compared with gas; but as regards the cost, comparing the only public system in operation—viz., the Jablochkoff—in the Avenue de l'Opéra, the result was unfavourable to the electric light. We want to be independent of any particular system, and to try such various modes of producing electric light as may be suggested from time to time. I concur with Dr. Siemens and with Mr. Bower as to the adaptability of St. George's Hall, and the neighbouring streets and public places, for the experiments we desire to make. I know of no place so suitable for the purpose of a large experiment, which will really show the commercial value of the electric light. I think the light might be applied with advantage to the approaches to the landing-stages; but I have not considered the desirability of applying the electric light to other parts of the estate; and, in the present state of affairs, I do not know whether it would be desirable to do so—that is rather more for the Dock Board. I am of opinion that there is no electric difficulty whatever in placing dynamo-electric wires beneath the footways under which the electric telegraph wires are placed. Without a clause in an Act of Parliament, the protection which is given under this Bill to the telegraph wires would not be given at all, and that is one of the reasons, no doubt, why the Bill is necessary. I do not mean to say that there would be any interference with the wires, but I can perfectly understand the Post-Office authorities desiring to prevent the possibility of such a thing being done. Power may be reclaimed to the extent of 40 or 50 per cent. at the distant end of the electric wire, and used for many purposes, such as hoisting, and all other operations to which small steam and gas engines are now applied; the same wires being used during the day that are used for lighting during the night. I think five years is quite as short as the time for such an experiment ought to be. I do not mean to say it would be impracticable to carry it out in a lesser time; but it would be very hard upon the Corporation for them to have to purchase engines and set up apparatus for a short time.

Cross-examined by Mr. BIDDER: An experiment like that on the Holborn Viaduct is no criterion in this instance. In that particular case, a French company applied to the Authorities to be allowed to fix the apparatus for a short time, giving them, no doubt, the option of carrying it on afterwards. That is not what we require; we wish to have our own apparatus, and to use every one of the dynamo machines, and any person's lamps. We cannot try the experiments now upon any system we please, because, in the first place, we cannot lay the wires underground; in the second place, I have no doubt we should have a difficulty with the postal authorities with regard to the national telegraphs; and, in the third place, I believe there is a difficulty about money, which we require powers to borrow. I have no hesitation in saying that the origin of the Bill was the difficulty about going underground, but I do not suggest that it was introduced in order to give the Post-Office authorities an opportunity for asking for a clause. When I made my report to the Town Council in December last, the experiment I contemplated then was limited to St. George's Hall and its approaches, and I should not even now recommend the Corporation to go into two or three experiments simultaneously; but I should suggest one at a time, which would be the most satisfactory way. We should not exactly first try one system and then another; we might try one machine and then another, but the same wires. [Witness pointed out on a plan the sites he considered suitable for the erection of engines.] The engine in the St. George's Hall is not of sufficient power for all the purposes we require. What we want to do is to combine the experiment of lighting public places and lighting interiors, and that has never yet been done. It is a most important thing it should be done, and until that is accomplished it is not a fair experiment. With regard to festooning the cable in the air, as mentioned by Dr. Siemens, electrically there is no objection to it; but æsthetically there is a very great objection—much greater than exists upon the Embankment, because, in the latter case, the lamps are so close together that the size and strength of the cable is necessarily small, as compared with what it would be where the lights are a greater distance apart. The system on the Embankment is a partial and subdivided one. The Jablochkoff system requires the lamps to be placed comparatively close together; while the systems we should probably apply, would involve the use, perhaps, of only three lamps for the whole of that space [pointing], and it could hardly be suggested that the electric cables should be festooned from those distant points.

Mr. BIDDER: Be that so; supposing your experiment is started, and your lamps placed where you have pointed them out, where you contemplate taking the cable underground, supposing there were any difficulty about getting it under the street, what is to prevent it being hung across William Brown Street, and then taken under the ground when you have reached your own premises?

Witness: It can be done, physically.

Then this Bill is to meet the æsthetic objection of the people in Liverpool?—I do not say so. I believe the Bill is necessary in order that we may obtain the money, and in order to protect the national telegraphs.

Cross-examination continued: The Corporation do not give permission to private individuals to open streets, although they may not take action in the matter if such a thing is done for any necessary purpose not contemplated by the Act. I never knew a resolution passed giving actual permission in such cases.

Mr. BIDDER: Is it correct that the British Electric Light Company offered to provide, at the cost of the Company, the necessary electric appliances to demonstrate the practicability of lighting the Picton Reading Room by the electric light, subject to the Corporation granting permission to drive a Gramme machine from one of the engines in St. George's Hall.

Witness: That is quite correct.

Do you recollect that the Library, Museum, and Arts Committee resolved to recommend to the Council to accede to that proposal, and to obtain the leave of the Health Committee for laying a wire, if necessary, under the roadway between St. George's Hall and the Picton Reading Room, for lighting the lamps?—I believe such a resolution was passed, but it has never been carried out, because we had no power to do so.

What became of that application andthat resolution?—I know this with

respect to it, that although the experiment is still proposed to be carried out, we do not propose to go under the road, but have contemplated hanging wires, as suggested, simply as a temporary matter; but it would never do to leave them up.

Then you are going to carry out the experiment without interfering with the surface of the road?—We must do so. If I were called upon to give my opinion, and were advising the Corporation about it, I should never recommend it as a permanent thing. That is a totally different matter to what we want.

Cross-examination continued: The existence of a single wire across a street for a few weeks might be put up with; but I will tell the Committee why it is important that we should do so in this instance, without regard to appearances. One system or another must be decided upon at once for the Picton Reading Room, because that is just about to be opened, and if we do not by some experiment of this kind demonstrate the utility of the electric light, gas lighting will be introduced, and we shall not have a chance of doing it at a future time. I have heard it stated that the capital of the Gas Company is one million and a quarter, and I am aware they are, under the authority of Parliament, the sole lighting authority of the city. They have a practical monopoly, but the Corporation could, if they chose, at a very short notice, cease to take gas from them entirely for public purposes, and could either place the town in darkness, or could arrange any other mode of lighting in the streets, if they had power to go under them. It is quite impracticable for us under this Bill to substitute electric lighting for gas over the Dock estate. The proposal is to light the approaches to the landing-stages particularly.

Mr. PEMBER: We cannot acknowledge the figure of the Company's capital, or anything like it.

Witness: I said I did not know; I took it from the learned counsel.

Re-examined by Mr. PEMBER: If experiments are to be carried out at all for five years, it cannot matter in the slightest to the Gas Company whether it is by the underground system, or by the wires being carried through the air. It is desirable that we should ascertain whether any practical difficulties arise when other people are using the light, and we are supplying it; difficulties which we may not observe when we are supplying the light to ourselves might crop up when we are supplying it to other people.

Mr. *J. Rayner*, examined by Mr. WRIGHT.

I am Town Clerk of Liverpool, and advised the Corporation as to the necessity for express parliamentary powers for the purposes of this experiment. In the first place, it is necessary to obtain such powers for the borrowing of a sufficient sum of money to test the experiment properly, and within a reasonable time; in the second place, I advised that it is necessary—or, at all events, it is doubtful whether it can be done without—in order to enable the Corporation to break up the streets and lay the wires; and, in the third place, the Corporation have no power to hold licences from patentees, and matters of that sort, without its being sanctioned by Parliament. With respect to the Postmaster-General, I consider the existing Acts would not give him the protection he requires, and which is to be given him. After long consideration and dispute, it appears to me to be quite clear that neither the Municipal Corporations Act nor the Public Health Act confers any general powers to break up the streets; in fact, the latter Act points rather to the contrary conclusion, because it enables the Corporation and the Urban Sanitary Authority to contract with any person for the supply of gas or other means of lighting the streets, markets, &c.; but in the second branch of the same section (161) it only enables the Corporation to obtain a Provisional Order, and thereby to incorporate the Gas-Works Clauses Act and other Acts, which will enable them to break up the streets.

Mr. MICHAEL: That is for setting up gas-works.

Witness: There is nothing to enable the Corporation to do anything with respect to the electric light; it is only in relation to gas-works.

Cross-examination resumed: With regard to the £50,000, it is perfectly clear by Act of Parliament that we have no power to make a rate, unless we are practically authorized, for the purposes of this experiment. That sum was put in at the beginning, when the Bill was first drawn; but, of course, it would be a mere bagatelle if the Corporation were contemplating anything more than an experiment.

Mr. WRIGHT: Any sum which you would find it necessary to have for the purposes of this experiment would either be provided out of the moneys borrowed under this Bill, or out of the surplus, if any, of the borough-fund?

Witness: Yes, the surplus income; and as to that there would be some doubt.

Cross-examined by Mr. BIDDER: I do seriously suggest to the Committee that a doubt about the breaking up of the roads was the cause of this Bill being introduced.

Mr. BIDDER: Did anybody ever raise any question or objection to your breaking up or interfering with the streets?

Witness: The time has never arrived. The matter was discussed at very great length, and I mentioned to the Committee who consulted me the Sheffield case, which is reported in the 18th Jurist——

Which had nothing in the world to do with this.—I beg your pardon. It was held that an injunction could not be obtained against persons for breaking up the streets under the sanction of the street authorities; but they were found guilty when they were indicted for a nuisance, and the Court refused to disturb that verdict, and it has never been disturbed to this day.

Those persons not being the public authority, but a private company trading for their own purposes?—No. The old Company did not give satisfaction in Sheffield, and therefore the Corporation encouraged the proposed new Company, and authorized them to break up the streets and lay their pipes, and the old Company thereupon applied to the Court of Chancery for an injunction, which was refused. They then indicted the whole of the parties at the Yorkshire Assizes, and they were found guilty, and the Court of Queen's Bench refused to disturb the verdict; therefore it is quite competent for a jury to find the Corporation guilty.

That being the case where a gas company with no parliamentary status, but simply trading for their own private benefit, provided lighting, and it was held that the Corporation had no power to give them a licence for breaking up the streets for private purposes?—They were doing it, I suppose, for the benefit of the inhabitants of the town.

They thought it was for the benefit of the inhabitants to encourage competition. Under the Public Health Act, all the streets are vested in you?—They were vested by a local Act before the Public Health Act, and we have the right of breaking them up for all purposes of the Sanitary Authority.

One of the purposes confided to you under the 161st section of the Public Health Act of 1875 is providing lamps and lamp-posts for the purposes of lighting the streets?—With gas. We may contract with any other person to light them with gas, or any other means, but we cannot ourselves have power to do anything but light them with gas.

You may contract with any person for the supply of gas or other means of lighting streets, markets, and public places in your district?—That is the very thing we do not want to do. We do not want to contract with any company.

You may provide such lamps, lamp-posts, and other materials and apparatus necessary for lighting the same. If you think a cable under the streets is necessary, you have a right to provide that?—I do not think so, because it is stated, "Where an Urban Authority may, under this Act, themselves undertake to supply gas for the whole or any part of their district, a Provisional Order authorizing a gas undertaking may be obtained by such authority."

That is gas, but we are not talking about gas. If they think a cable under the street necessary, what on earth is to prevent them putting one down, when the section says they may?—It does not say so. That section only applies when they contract with some other persons to light the town.

With regard to the streets, the soil underneath is yours, is it not?—It is only vested in us for certain purposes.

One of which is lighting. If anybody was so fractious as to raise an objection to your breaking up the streets in the ordinary way, what is to prevent you carrying it underneath?—We could not tunnel under those streets without considerable increased expense.

Physically you could do it?—I do not think the Corporation should be placed in that position.

You sometimes close these streets for the purposes of paving; would it be illegal to avail yourselves of those opportunities to lay down a cable?—I think it would be very improper to take advantage of the paving of a street to do something which is not authorized, because it would be doing it under a false pretence, and the Gas Company might very reasonably complain that we were paving the street on purpose to do so; besides, we should not like to repave a street which did not require it, for the purpose of laying a cable down.

As to the origin of the Bill, in point of fact did it not grow out of a Committee appointed by the Corporation to try and purchase the Gas Company?—Not a Committee for that specific purpose, but a special Committee as to the gas supply generally, which was re-appointed from time to time.

Cross-examination continued: The last report of the Committee was made in October, 1878, in which an application for this Bill was recommended. The Council, however, did not adopt the recommendation in the precise terms of the Committee, but on the 30th of October they passed the following resolution:—"That the necessary parliamentary notices be given of an application to Parliament next session for powers to authorize the Council to take all necessary steps and execute the requisite works for lighting the public streets and places and buildings belonging to the Corporation within the borough by means of the electric light, and with powers to supply such light to any person or persons or companies who may require the same, and for such further powers in connection therewith, or with the gas-works, property, and undertaking of the Liverpool United Gaslight Company, as may be considered by the Council to be requisite or desirable."

Mr. BIDDER: Not one word there about experimental purposes?

Witness: There was not in the first instance. The only suggestion as to an experiment in the Bill as deposited was the borrowing of the £50,000.

The Bill before their lordships is a very mild one, simply to obtain the necessary powers to enable you to try a little experiment, without any desire of hurting the Gas Company; but as originally introduced it was a Bill to make further provision for the lighting of the borough of Liverpool, and for other purposes?—The reason why those clauses were put in was the purchase by agreement——

I am told the notices extended to the whole district of the Gas Company?—But the moment the Council considered it they cut it down to the borough. On the 15th of January, 1879, the Council considered the Bill for the first time, and the resolution was—"That the powers of the Liverpool Lighting Bill, with respect to the electric light, be limited to the borough of Liverpool." The second was—"That the provisions of the Bill be limited to conferring the requisite powers upon the Corporation with respect to streets and their own buildings, and to supply the electric light by agreement to other bodies and persons, but so as not to restrict any person from supplying his own or adjoining premises without thereby breaking up, crossing through or over, or otherwise interfering with any part of any public street." The third is—"That the permissive powers in the Bill, with respect to the purchase of the gas-works, be altered so as to provide for the purchase by mutual agreement only, but omitting the provisions allowing the Corporation to agree to leave the terms of purchase to arbitration under the Lands Clauses Consolidation Acts."

The Bill is required to enable you to supply electric lighting all through the borough, both for public and private lighting; that is to say, to place you in a position which will authorize you to compete with the Gas Company through the whole of their district within the borough?—In the sense in which you use the word "compete;" not in the sense in which we use it.

So that if the Bill had passed in that form, the Gas Company would have had the alternative, at the most, either to agree with you to sell their undertaking upon such terms as might be agreed, or face your competition in the borough of Liverpool?—The clauses were put in for agreement in the event of the Gas Company and the Corporation coming together.

In the event of the electric competition making the Gas Company reasonable. Now, in point of fact, in order that their lordships may appreciate the bearing of the proposed legislation, the Public Health Act practically prohibits the Urban Sanitary Authority, where there is a properly established gas company, from competing with them within their district, does it not?—I do not know that; but I am perfectly familiar with the section under the Borough Funds Act. That Act simply says that you shall not apply part of your funds for the purpose of establishing gas-works, where such works are already in existence.

That looks very much as if you might not even come to Parliament, or might not even use your borough funds to come to Parliament to obtain authority to compete with an existing gas company?—That would be so, no doubt.

Are you not aware, also, that under the Act of 1875 you cannot supply gas except where there is no gas company already established?—You cannot, under the Public Health Act. You can only go for a Provisional Order when a gas company is not established.

The practical result is that you are prohibited from competing with a gas company by means of gas, and, consequently, you cannot by any competition compel a gas company to sell their undertaking to you at what you would call a reasonable price?—That is a different matter altogether. There is nothing to prohibit going to Parliament to buy up the gas-works.

Cross-examination continued: I do not think the scope of our Bill creates at once an electrical competition. It is simply to establish the electric light for those who choose to take it from us by agreement. If the Bill passes, I do not think it will depreciate the shares of the Gas Company; my impression is that it would rather improve them. The price of the shares went down long before we gave notice of our Bill, but that depreciation was not caused by any action of the Corporation. On the contrary, they have improved in value since we gave notice for this Bill. Supposing we supply the electric light to all the places which have been mentioned, I do not think it will affect the value of the Gas Company's undertaking. In the first place, with regard to our own premises, we can

light them now with the electric light, if we choose, supposing we can do it without borrowing any money; and, in the second place, there is no prospect of our lighting more than the approaches to the Dock Company's premises. If they wish to light the whole of their premises by electricity, they could it much better than we could.

Mr. BIDDER: But, in fact, you take power under your Bill to light the whole of their premises, and also any railway station, public slaughter-house, or theatre?

Witness: You are assuming an impossibility, because the whole thing is limited by the £50,000.

Supposing you were not content with that, but were to take the shops and the churches and chapels, do you think that would touch the Company's revenue?—It would do so.

With regard to your not having the power to break up the streets, let me call your attention to the case of *Coverdale v. Charlton*, in which it was stated that "the words of this section vest the property in the street, and the street does not include the houses by the side of the street, but it includes the space between the houses, which is used as the footway and roadway." The word "street" means more than the surface; it means the whole surface, and so much of the depth as is or can be used not unfairly for the ordinary purposes of a street. It comprises a depth which enables the Urban Authority to do that which is done in every street—viz., to raise the street and lay down sewers, for at the present day there can be no street without sewers—and also for the purpose of laying down gas and water pipes?—That assumes that they have the power to do that.

You may quarrel with the Court of Appeal if you like?—That has reference to a totally different matter. It assumes that they have the power to light with gas. The question of nuisance never arose in that case at all.

Mr. PEMBER denied that any such judgment had been given.

The CHAIRMAN observed that the concluding portion of the report of the Committee of the House of Commons on that point distinctly summed up by saying that there seemed to be some conflict of evidence as to whether the existing powers were sufficient or not. It was rather a question now whether they should discuss that point, because it might be a very large matter if they had to determine it.

Mr. BIDDER: From one point of view it is a very large question, and from another point it is not; but it will not be necessary to trouble your lordships at great length about that. (To witness:) I have your Act here, according to which, if anybody breaks up the pavement of any street in Liverpool without the consent of the Town Council he may be fined £5.

Witness: Yes.

Supposing anybody breaks it up with the consent of the Town Council, what would happen?—That implies some temporary purpose, and the person would not be fineable.

Then if you choose to give consent to any tradesman to break up these streets, laying a cable for your own use, he will not be punishable?—I think he would, because the Corporation would be going beyond their powers.

Used you not to give permission to the Telegraph Company to break up the streets for the purpose of laying their cables?—I do not think so. I do not remember their ever breaking up the carriage way, although they laid lines of cable under the footways in some cases a long time ago.

I understand you concede that if you give any person the consent of the Town Council for breaking up the street for the purpose of introducing the electric cable, nobody can punish him?—I do not say so; he would still be indictable for a nuisance.

A MEMBER of the COMMITTEE: The Council can only give the power if they have it themselves.

Another MEMBER: I understand it is admitted that they have no power.

Mr. BIDDER: You said that another reason for desiring to promote this Bill was that you had no power to borrow money without it. The Corporation of Liverpool, as you recite in the preamble, have a surplus in their borough-fund.

Witness: A very small one—only £3000 odd. They have a large property but not a large surplus, and they have to levy rates every year, notwithstanding their income.

If your Bill had contained powers simply to borrow money and to go under the streets, that is all which would be requisite to try the experiment?—We should have asked for power, also to take grants of patents, and so on, because it is impossible to say what we may have to deal with.

Do you mean to say that if at the present moment the Corporation of Liverpool want to use a patent article, they have no power to do so if they pay a royalty?—If they use it for the purpose authorized, they can.

An electric patent is only for the purpose of being used for electric lighting?—It was considered a necessary incidental power that we ought to possess.

Do you mean to suggest that you have not power to pay a royalty to the patentee for the use of his apparatus?—Always assuming that we have power to use it at all.

Re-examined by Mr. PEMBER: The object of the section imposing a penalty of £5 on any person breaking up the streets was to prevent people altering the carriage ways to suit the entrances to their premises; but that clause cannot be construed into giving us substantive power to break up the streets for the purpose of laying down electric wires.

Mr. PEMBER: With respect to the supposed judgment of the Court of Appeal, I trust the Committee will allow me to state that that was no judgment at all. It is only in the course of the different judgments, but is not the decision of the Court. Baron Bramwell takes the opportunity to say "street" means more than the surface; it means the whole surface, and so much of the depth as is or can be used not unfairly for the ordinary purposes of a street. It comprises a depth which enables the Urban Authority, "if they have the power," which Baron Bramwell supposes, "to do that which is done in every street—viz., to raise the street and lay down sewers," &c. That is to say, that if they have the power to lay down gas and water pipes in every street, then they may use so much of the *solum* under the street as is necessary for the purpose?—But that supposes the power, on which point we took the advice of our ordinary legal advisers, and they told us we had not such power.

If the inference to be drawn from the words of clause 161 of the Public Health Act be that you could put a cable under the streets without express power, would not any company who had power to supply and deal with gas by inference be enabled to put gas-pipes under the street?—Yes.

You said there was nothing about experiment in your Bill as originally introduced. If you had powers to supply the electric light in permanence, it would not be necessary to give you power to experiment?—It was intended as an experiment in this sense—that we only intended to test it.

I suppose you concur with other witnesses in saying that experiment cannot perfectly be carried out unless you have all the powers of this Bill?—I do not think it can be satisfactorily carried out. The object the Council had in view was that, if they had to go to an extra expense in lighting Lime Street, where there is an immense amount of fast cross traffic—mainly the approaches to the arrival and departure platforms of the railway station—they thought it fair to have the means of agreeing with the railway company, if they could, to light the station by means of the same appliances with which they lighted the street and the adjoining open spaces, because it is only in that way that the economy of the light can be tested.

Mr. PEMBER said that was the case for the promoters.

Mr. ASPINALL, in addressing the Committee for the petitioners, pointed out that the property of the Liverpool United Gas Company was a very valuable one, an enormous amount of capital having been invested, and consequently, it was a question of great importance to them that that property should be protected. The Corporation had previously negotiated with respect to the purchase of the Gas Company, and as soon as the electric light was talked about for practical purposes, they introduced a Bill into Parliament. Nothing was then said about experimental purposes, but the electric light was for all purposes; and for the Corporation to become the electric lighting body would be the means of depreciating the undertaking of the Gas Company as a competitive body. The House of Commons had appointed a Select Committee on this subject, who were struck with the importance of the question, and they had reported at great length, and decided that the Corporation could experimentalize, the clauses of a commercial character being struck out. The learned counsel then referred to the merits of the Bill, and contended that it should not pass that House, considering how seriously it affected the petitioners.

The committee-room was then cleared. After a consultation lasting for half an hour, the public were re-admitted, when

The CHAIRMAN said: The Committee consider that the preamble of the Bill is proved.

The clauses were then gone through, and the Bill was ordered to be reported, with amendments, to the House.

Legal Intelligence.

MANCHESTER SUMMER ASSIZES.

NISI PRIUS COURT—TUESDAY, JULY 22.

(*Before Justice* LUSH, *and a Special Jury.*)

CLAYTON AND OTHERS *v.* CORPORATION OF WARRINGTON.

INJURIES CAUSED BY AN EXPLOSION OF GAS.

This was an action brought to recover compensation for injuries sustained by the plaintiff and his family through an explosion of gas, which, they alleged, was caused by the negligence of the defendants. The plaintiff, William Clayton, resided with his wife and family in Dallam Lane, Warrington. On the night of the 23rd of September last an explosion occurred in the plaintiff's house, caused by an escape of gas into the house from one of the Corporation mains. The windows of the room in which the explosion occurred were blown out, the floor was torn up, and Mr. Clayton and his wife and two children sustained severe injury. The furniture in the house was destroyed, and a claim for £26 was made in respect of it. An examination of the pipe showed that at the point of fracture there had been an "air blow" in the metal, which reduced its thickness to the 32nd part of an inch, thus rendering it quite unfit to resist even ordinary pressure. It was laid 2 feet below the pavement in front of the plaintiff's house, and in consequence of the defect it had given way under the weight it had to bear, owing to a subsidence of the earth immediately beneath. It was admitted that the pipe in question was laid in 1861, at which time the gas-works were in the hands of the Warrington Gaslight Company. The defendants became possessed of the works in 1877, and they contended that, as they were not the same persons who had laid the pipe, but a different corporation, they were not responsible for what was done by their predecessors. For the plaintiff it was urged that an inspection of the pipe at the time it was laid down would have shown that it was not fit to be used for the conveyance of gas from the mains. The facts of the explosion were not disputed, the only question being whether the defendants had been guilty of negligence.

Mr. GULLY, Q.C. and Mr. MATTINSON appeared for the plaintiffs; Mr. RUSSELL, Q.C., and Mr. TAYLOR for the defendants.

Mr. GULLY contended that in taking over a concern which had defects in it caused by the neglect of the original owners, the defendants must stand the brunt of such defects, as of all other liabilities of the undertaking.

Mr. RUSSELL said that to make the defendants responsible for an act of negligence which was not theirs, there must be an express statutory provision putting the consequences of that negligence upon them.

Justice LUSH: That is my opinion. Is there any authority that the Gas Company themselves would have been liable in such a case as this?

Mr. GULLY: I think my learned friend concedes that if the Company had laid the pipe, and laid it negligently, they would have been liable.

Justice LUSH: I do not think you have any case at all, Mr. Gully.

Mr. GULLY: If we have no remedy against the Corporation, it must be taken that the effect of their Act of Parliament is to take away our remedy.

Justice LUSH: That is, if you had it against the Gas Company, of which I am not at all sure.

Mr. GULLY: I think there would be plenty of authority for that.

Justice LUSH: There may be, but at present I am not familiar with it. I feel very strongly that the Act of Parliament does not transfer the liability, and does not make the Corporation responsible for defects in pipes laid down by their predecessors. You cannot say it was the duty of the Corporation to go and overhaul the whole of the gas-mains to see if they were in proper condition before they were transferred.

Mr. GULLY: I cannot say that.

Justice LUSH: Then there is no negligence on their part.

Mr. GULLY: Unless they are identified with the Gas Company.

Justice LUSH: I must decide against you; but lest I should be mistaken, can you agree upon any amount of damages? I think you had better do that.

Mr. RUSSELL said he must not be understood as admitting that there was negligence, even on the part of the Company, in the laying of the pipes. He was prepared with evidence to show that the pipes were tested when laid, and that the defect in question was not known.

Justice LUSH: The truth is, this is a casualty not foreseen when Acts of Parliament of this kind are passed. I suppose the Corporation Act does not provide for any accident-fund?

Mr. RUSSELL: No; there is nothing but the borough-fund.

Justice LUSH: Then of course the Corporation cannot pay unless they are legally liable.

Mr. RUSSELL: Your lordship will understand that the Corporation were obliged to raise this question, because to admit their liability here might have exposed them to they knew not what claims in the future. Therefore they felt bound to take your lordship's opinion as to whether they were liable. After your lordship's expression of opinion, my learned friend will consent to judgment being entered for the defendants; but I may add that the Town Clerk is authorized by the Corporation to give to the plaintiffs £100.

Justice LUSH: I am very glad to hear that. It is what I should have liked to have recommended if I had had the power to do so. I think the Corporation are behaving very well. I may now say I have no doubt whatever that they are not liable.

A verdict was then entered for the defendants.

SOUTHWARK POLICE COURT.—Monday, July 21.
(*Before Mr.* Partridge.)

THE NECESSITY FOR OBTAINING DEPOSITS BEFORE SUPPLYING GAS.

Mr. *I. A. Crookenden*, Secretary of the Phœnix Gas Company, was summoned by Mr. Albert George Hannay, bookseller, of 98, Blackfriars Road, for unlawfully disconnecting the gas from his premises, and depriving him of his supply of gas, the Company holding sufficient moneys in hand to pay his demand.

Mr. Hope, jun., appeared in support of the summons, and Mr. Hall on the part of the Company.

The *Complainant* said that in March, 1875, he took the premises at 98, Blackfriars Road, and required a supply of gas. At the time he left with the Company £5 as a deposit. He paid the accounts regularly up to July, 1877, when, as he was short of money, he asked the collector to deduct the sum due from the deposit, which was reduced to £3. After that he paid regularly, and at Lady-day last he owed £2 17s. 9d. When that was applied for, he asked the collector to deduct it from the deposit. He was told to call at the office about it. He, however, did not call, and on the 20th of June he received a notice from the Company that unless the £2 17s. 9d. was paid the gas would be disconnected. A day or two afterwards he went to the Company's office, and asked that the sum should be deducted from the deposit note of £3 to settle the account, but at that time he owed £1 5s. 4d. more for gas supplied to Midsummer. As he was not prepared to pay, the gas was disconnected.

In reply to Mr. Hall, witness said he burnt gas up to Midsummer when he knew that the Company held only two-thirds of the deposit of £3.

Mr. *A. E. Allen*, chief arrears collector of the Company, said that he applied for the £1 5s. 4d. due, and as it was not paid, the gas was disconnected on the 27th ult. The complainant was asked for a further deposit prior to that, but declined to accede to the request.

The Magistrate said that he did not see anything for the Company to answer. They were entitled to a deposit, and as complainant had consumed gas beyond the £3 deposit, and neglected to pay for it, they were justified in discontinuing the supply.

Mr. Hall said he had no desire to be unkind toward the complainant, but his name appeared in the *London Gazette* of Friday, a copy of which he handed in. The Company would, he stated, connect the gas again as soon as complainant paid the £1 5s. 4d. arrears, and made another deposit of £3.

The Magistrate considered it a very proper proposal, and dismissed the summons.

Mr. *Hannay* was then summoned for neglecting to pay £1 5s. 4d. arrears due to the Company, and, after hearing evidence, Mr. Partridge made an order for payment, and, in default of distress, defendant to be imprisoned.

Miscellaneous News.

METROPOLIS WATER SUPPLY.

Lieut.-Col. Bolton reports that the state of the water in the Thames at Hampton, Molesey, and Sunbury (where the intakes of the West Middlesex, Grand Junction, Southwark and Vauxhall, Lambeth, Chelsea, and East London Water Companies are situated), was bad from the 1st of June to the 5th; it then slightly improved, and remained in a better condition until the 8th, when it was turbid and bad until the 20th, after which it again slightly improved, but continued in an indifferent state for the rest of the month. The highest flood state of the river at West Molesey during the month was 4 ft. 7 in., and the lowest 1 ft. 10 in. above the summer level, the rainfall at this place being 3·72 inches. The water in the River Lea was indifferent during the whole of the month.

The following is Dr. Whitmore's report on the composition of the water supplied to Marylebone during June:—

June.	In Grains, per Gallon.							In Parts, per Million.		In Degrees.	
	Total Solid Matter.	Loss by Incineration.*	Chlorine.	Equal to Chloride of Sodium	Nitrogen as Nitrates and Nitrites.	Oxygen required for Oxidizable Matter.	Estimated Organic Matter.	Free Ammonia.	Albumenoid Ammonia.	Hardness.	Hardness after Boiling Fifteen Minutes.
West Middlesex	21·00	0·84	1·18	1·94	·116	·039	·312	·01	·09	14·4	4·8
Grand Junction	22·60	0·88	1·26	2·08	·117	·041	·328	·00	·09	15·3	4·9
River Thames at Hampton	24·06	1·31	1·26	2·08	·108	·091	·728	·04	·22	16·4	5·2

* The loss by incineration represents the amount of organic and other volatile matters contained in the Imperial gallon (70,000 grains) of water. The total solid matter, *minus* such loss, consisted chiefly of carbonate of lime, with small quantities of other equally harmless salts.

Temperature of West Middlesex water as drawn from the main 60° F.
Temperature of Grand Junction water as drawn from the main 61° F.
Temperature of the Thames water as taken from the river . . 59° F.

The West Middlesex water was clear and bright, but slightly coloured; the Grand Junction water was also coloured. The water taken from the River Thames at Hampton was unusually turbid for the month of June.

METROPOLIS GAS SUPPLY.

The following is Dr. Whitmore's report on the illuminating power, pressure, and quality of the gas supplied by The Gaslight and Coke Company to the parish of Marylebone during June:—

June.	Illuminating Power in Sperm Candles.			Mean Pressure in Tenths of an Inch.		Mean Quanty. of Sulphur in 100 Cu. Ft.	Mean Quanty. of Ammon. in 100 Cu. Ft.	Sulphuretted Hydrogen
	*Mean of 22 Obser.	Highest.	Lowest.	Highest.	Lowest.	Grains.	Grains.	
Common gas . . .	17·19	17·60	16·46	34·61	13·8	13·80	0·26	No trace
Cannel gas . . .	21·28	23·34	20·54	22·20	12·36	10·30	0·23	No trace

Mean of daily readings of barometer . . . 29·58
" " " thermometer . . . 69·07

* Each observation consists of ten readings of the photometer, at intervals of one minute.

The mean illuminating power of the common gas, was equal to rather more than 17 candles, and on no occasion did it fall below the standard of 16 candles; on 18 testings it exceeded 17 candles. The mean amount of sulphur found in 100 cubic feet of gas was rather less than 14 grains, and of ammonia about the fourth of a grain. The mean light of the cannel gas equalled that produced by about 22 candles, and this gas also never fell below the legal standard; on four occasions it exceeded 23 candles. The mean amount of sulphur found was 10½ grains, and of ammonia the fourth of a grain. The pressure of both gases was very good, and on no occasion was sulphuretted hydrogen detected by the ordinary tests.

DEVONPORT GAS COMPANY.

The Thirty-fifth Annual Meeting of this Company was held last Tuesday—Mr. R. C. Smith in the chair.

The Secretary (Mr. J. Willing) having read the notice convening the meeting, and the list of Shareholders having been sealed, the following report of the Directors was presented:—

The accounts, after providing for outstanding liabilities, and payments in February last of the half year's dividend then due, show remaining a disposable balance of £2938 10s. 4d. from which it is now proposed to declare a dividend at the rate of 5 per cent. on the original shares and 3 per cent. on the guaranteed shares, amounting together to £2110 16s. 7d., which will leave a balance of £827 13s. 9d. to be carried forward to the next account.

The increment in the consumption of gas for the past year has been at the rate of 7½ per cent. as compared with 6 per cent. in the preceding year.

A new gasholder has been completed to the satisfaction of your Directors and their Manager. A considerable extent of mains and services has been overhauled, and the work of renewal is steadily progressing.

The Overseers and Rating Committee of the Council having assessed the works considerably in excess of the former rate, the Directors appealed, and the rate was quashed. The Committee have since revised the assessment, reducing the amount to £2390 net, being about double the amount of the previous rate. It being understood that the rate is only provisional, the Directors have consented to postpone further action for the present.

With deep regret the Directors record the death of an old and respected officer, Mr. W. Robinson Screech, the late collector. Mr. Alfred Screech has been elected to the situation so long filled by his late father. Two of the Directors, Mr. Charles Easterbrook and Mr. Thomas Hawker, who retire by rotation, being eligible, offer themselves for re-election. Mr. Charles Bearblock, the retiring Auditor, also offers himself for re-election.

[From the accounts it appears that the authorized original capital of the Company was £50,000; loan capital, £15,000; total, £65,000. Payments made on original shares, guaranteed share and debenture bonds, £57,178, leaving an available capital balance, that could be raised if required of £7822. Receipts for the year ending May 31, 1879, £19,766 12s. 5d.; expenses for the year, £15,318 14s. 1d.; balance profit, £4447 18s. 4d.; balance added from previous year, £2712 5s. 2d., showing a net revenue of £7160 3s. 6d. To dividends declared May 31, 1878, £2110 16s. 7d.; Nov. 30, £2110 16s. 7d.; balance available for dividend, £8938 10s. 4d. The balance of the assets and liabilities of the Company showed the same available balances, allowing for a reserve-fund standing at £3905 5s.]

The Chairman moved that the report and accounts presented be received and adopted. He said that the accounts now submitted did not bear so favourable an aspect as those which the Directors had been able to place before the Proprietors on the last two or three occasions. That was partly to be accounted for by there having been, during the past four years, a consecutive reduction in the price of gas. During the last year the full force of that reduction had been felt. The amount of the revenue during the year suffered a reduction of £5000 from what it would have been had the price of gas remained as it was four years since. There were some other circumstances which would also practically account for the less favourable results shown. The revenue account did not show the decided loss of the amount that he had named, as there had been a steady increase in the consumption of gas, which had in a great measure recouped the loss. To the reduction in the price of gas that increase in the consumption was principally to be attributed, and this had now reached something over 20 per cent. The increase during the past year alone had been at the rate of 7½ per cent. There was, however, another cause to which it was to be largely attributed—the very long and severe cold season. An increase had also arisen in the consumption of gas for cooking purposes. The additional revenue from those sources did not make up the difference in the loss that had arisen from the reduction in price, and the Directors were unable to add any amount whatever to the reserve-fund. During the coming year there would also be an extra claim upon income for increased rates and taxes. The Town Rating Committee had seen fit to make that increase, though the Directors believed that if the Committee had fully considered the Company's position they must have felt that consideration was deserved. The Company were under a lease for the supply of gas for 14 years to the Corporation. During the last three or four years the Directors had made several reductions in the contract prices they were enabled to charge. Those reductions now amounted to 1s. per lamp, being a saving of about £280 per annum to the town, or equal to about a 1d. rate on the rateable property in the borough. Some persons suggested that the Directors could return to their original contract prices. They certainly had that power, and would exert it if deemed necessary. At present, however, they did not entertain any such intention. When Mr. Cross visited that town, the Directors received a communication from the Town Clerk that the rates had been increased from £1600 to £3725, and the net rating value from the previous £1200 to £2980. The Directors protested, and after some consideration the Rating Committee reduced the rates by £300. The Directors thought the reduction was not sufficient, and appealed, and before the Recorder it was universally admitted that the rate was so irremediably bad, so many omissions and anomalies had been shown, that it was quashed. Since then further communications had been received from the Committee that they had still further reduced the rate to £2390 net rateable value. The Directors were, however, advised that that was merely a tentative rating, and that when the Valuation Bill had been passed by the House of Commons, the whole rating of the borough would have to be gone over again. The Directors, therefore, did not propose to take any further action for the present. The whole matter, it must be remembered, did not so much affect the Shareholders or the Directors as it did the gas consumers. The gas consumers would have to pay something more for their gas, either by an increase to meet the increased rating, or by the Directors having to defer for the present any further reductions in the price of gas; in fact, it would postpone any reduction for some time to come. The only ratepayers who would benefit would be those who were not gas consumers. There was one item in the accounts that no doubt the Shareholders had observed which, although small in amount, was very significant. He referred to the fees for the transfer of shares, which had increased this year about 50 per cent. in consequence of the unusually large number of transfers that had been made. That had largely arisen from the "scare" last August about the development of the electric light. The number of Shareholders who transferred shares was 45, and the number of shares transferred 386, a large number being thus sold in addition to the 16 transfers of shares, 484 in number, that had arisen through probates and letters of administration, making in all 61 transfers and 870 shares transferred—far more than usually took place. Respecting the electric light, he believed it would take a very long time before it could work out gas for general use and general purposes. Something might happen, as a large increase in the price of coals, to double or treble the present price, as occurred a few years since, and this might raise the price of gas to a figure that would bring the electric light into general competition; but at present he saw no fear of its adaptation to domestic purposes.

Mr. W. Colwill seconded the proposition, which was carried unanimously,

Mr. Pillman asked whether the Company was limited to a certain amount of reserve-fund, and as to the price that could be charged for gas.

The Chairman said the reserve-fund, with the interest, amounted to over £4000. The Company was limited to £5000—one-tenth of the capital—the usual course adopted by Parliament. The Company's limit in charges was 6s. per 1000 feet.

Mr. Oram explained that in the difference between the Company and the Rating Committee there had been the greatest courtesy. There was no ill-feeling whatever—it was only difference of opinion.

It was then resolved that a dividend be declared for the past six months, ending May 31, 1879, of 5 per cent. on the original capital and 3 per cent. on the guaranteed shares, free of income-tax, and payable on the 1st of August next; also that the Directors be empowered to pay an intermediate dividend for the six months ending Nov. 30, 1879, at a rate not exceeding 5 per cent. on the original shares and 3 per cent. on the guaranteed shares.

The retiring Directors and Auditor were re-elected; and, on the proposition of Mr. Pillman, seconded by Mr. Cannon, a unanimous vote of thanks was awarded the Directors and Officers for their services for the year.

The Chairman and re-elected Officers acknowledged the compliments paid them, and the meeting terminated.

BIRMINGHAM CORPORATION GAS SUPPLY.

A Meeting of the Birmingham Town Council was held last Tuesday—Alderman Avery in the chair—when the Gas Committee reported that they had made contracts, on favourable terms, for the purchase of 295,000 tons of coal for the year 1879-80, and also for the sale of the surplus tar. The contracts had been made on more advantageous terms than last year. They also reported that the Bill for the repeal of the differential charge with reference to Yardley and Northfield gas had come before Parliament, and that the preamble was proved. They had obtained the insertion of a clause in the Bill, providing that the repeal of the differential rate shall date from the 30th of September next. They further reported certain negotiations with the Solihull Gas Authorities with reference to existing arrangements for the supply of gas to Olton and Solihull; and, subject to the approval of the Council, they proposed to enter into an agreement with the Solihull Gas Company in the following terms:—That the Solihull Gas Company shall undertake not to supply gas beyond a limit of 2000 yards from the Public Hall of Solihull, and that the Corporation shall undertake not to supply gas within that limit; that the agreement shall be for a period of 14 years, and that neither party shall apply for any parliamentary powers touching the supply of gas in the parish of Solihull except in the last year of the term of the agreement. The Committee stated that the sale of gas for the half year ending the 30th of June had been 1,338,050,300 cubic feet, as against 1,217,455,300 cubic feet in the corresponding half of 1878, being an increase of 120,595,000 feet. The average illuminating power for the same period was 17·28 candles. The number of new services supplied in the half year had been 1004, being a decrease of 330 as compared with the corresponding period of last year. The number of articles supplied by the Gas Department for the same period was 107 gas-fires, 76 cooking-stoves on hire, and 139 cooking and heating stoves sold. They reported an improvement in the sale of coke for domestic purposes. The stock of coke was less by about 5000 tons than at the corresponding time last year, and was rapidly decreasing.

Mr. Marris, in moving the adoption of the report, drew attention to the increase in the sale of gas, which amounted to 9·90 per cent. By shortening the period of taking the state of the meters the return for the present half year was less by about 30 millions than it would have been, so that the increase practically amounted to 12 per cent. With regard to the Northfield and Yardley Gas Bill, he said that the Committee purchased the right to the charge which they made. The extra 1s. per 1000 feet charged to Northfield and Yardley produced £1250, and the capitalized value of that would be £32,000. The Committee believed they were as much justified in defending that portion of their property as any, and the Council had confirmed their opinion as to the necessity of opposing the Bill. A differential rate was charged in nearly all the large towns of the kingdom, and in many of them the lower price was limited to the borough boundary, and every resident outside it had to pay the higher rate. In some cases a much higher price was charged. It had been said that they did not charge Sutton Coldfield the same price; but the circumstances there were different. They had supplied that place for two years only, and already had a consumption of 2 million feet per mile of main, while in Northfield and Yardley the consumption, after 14 years growth of the district, was only 1 million feet per mile, and the supply was, therefore, much more costly. The mains in Sutton Coldfield cost £5000, and the consumption was 10 million feet per annum; the mains in Yardley and Northfield cost £24,000, and the consumption was but 25 million feet per annum. The reported arrangement with regard to Solihull and Olton was, he considered, perfectly fair and satisfactory.

Alderman Biggs inquired what the cost of the opposition to the Differential Charges Repeal Bill amounted to. He complained of the terms which the Committee had made for supplying gas to Messrs. Elliott in the Northfield district at a cheaper rate, without having consulted the Council, and expressed regret that the Committee did not attempt to effect a compromise when the Bill was before the House of Commons.

Mr. Beard said the point raised by Alderman Biggs was not of such importance as it appeared, although it probably induced other consumers in the district to ask for a reduction, and had its influence upon the House of Commons. The circumstances were altered since the time of the Staffordshire Gas Company. He did not think the extra price should have been wholly remitted, but it was not fair to continue the old charge. When the Committee asked for permission to oppose the application, he thought it would have been better for the matter to be settled by mutual arrangement, and he was still of that opinion.

Mr. Marris, in reply, said he believed the costs of the action the Committee had taken with reference to the Bill would be very small, but at present they were not ascertained. Alderman Biggs had brought a very serious charge against the Committee, and one which he ought not to have made. He said that the Committee had gone outside their powers to do something they ought not to have done, the result being that they had sustained serious loss. He (Mr. Marris) would, however, remind Alderman Biggs that the Gas Committee had full powers vested in them, although it was quite true they had frequently taken the Council into their confidence. They had certainly, from time to time, asked the Council to sanction certain large items of expenditure they had incurred, but no one had the right to say they had gone outside their powers to do something they had no right to do. As regarded the mutual arrangement spoken of by Mr. Beard, he said that it was perfectly clear to the Committee that no satisfactory arrangement was possible under the circumstances. Before the Bill went to the House of Commons, the Committee had met a deputation in a very conciliatory spirit, but it was found that no arrangement could be come to.

The resolution was then agreed to.

NORTH BRITISH ASSOCIATION OF GAS MANAGERS.

(*Continued from page* 104.)

Mr. P. Watson (Stirling) read a paper on

THE EFFECTS OF FROST ON GAS APPARATUS.

The object of this society, as you all know, is primarily to encourage and advance all matters connected with gas engineering and manufacture, and to facilitate the interchange of ideas; and, in accordance with this object, I have prepared a short paper, giving the results of my practical experience during the severe and protracted winter that we have just passed through.

First of all, I shall make a few remarks on gasholder-tanks. In former winters I have been put to a great deal of trouble and inconvenience in preventing the holders getting bound with ice, and many of you, I have no doubt, will have been in the same position, especially if your holders stand at some distance from the works, as mine do. In the early part of the storm, I found one morning that the needle of the thermometer had gone down to zero during the night, which means 32° of frost. Seeing this, I thought the sooner something was done the better, so I went to a wood merchant, and got as many boards as were sufficient to cover in both tanks. These boards were from 12 to 14 feet in length, 12 inches in breadth, and ¾-inch thick. These I laid flat, the ends resting on the cope, the inner edge close to the holder, and overlapping one another so as to form the circle. On the top of these I laid a good thick coat of straw, and the result, I am glad to say, was a complete success. During the whole of the storm the frost never got to the water through this protection, and, of course, I had no further trouble with the tanks. This, I assure you, was a great relief.

As to the effects of frost on main-pipes, I may say that about the end of the storm we had a 3-inch main completely closed up. About 30 yards of the main lie on trap rock, about 14 inches from the surface of the ground—the road being lower now than formerly, in consequence of the action of the Road Trustees in scraping away the metal, and not replacing it. Here the supply of gas got small by degrees and beautifully less, until the street was in complete darkness. There are two level crossings in this street, and it was necessary that something should be done. We therefore set to work, and, by the aid of hot water, got the ground thawed. Then we tapped the main for a ¾-inch iron pipe. We had two gallons of methylated spirits ready, and we poured one gallon down as fast as the ¾-inch pipe would permit, reserving the other for night; but I was delighted to find that no more was required. The supply of gas thereafter became as bright and as strong as ever. With reference to the cause of this obstruction, I may state that in the winter of 1860 and the spring of 1861, my attention was called to the failure of the supply of gas in all the bed-rooms of the Crown Hotel, Falkirk, where I was at that time, and as we had to compete with a rival company, I had to do many things to keep in the good graces of the consumers. I, therefore, went in under the roof, where the pipes were laid which supplied the bed-rooms, and found that they were all laid upon runs with a good slope, and I was at a loss to understand the cause. However, I put my knife through the pipe, and I found to my astonishment that it was completely filled up with the frozen vapour from the gas, having much the same appearance as telegraph wires during a severe frost. I applied spirits of wine to the pipe, and found it so very useful that I have come to be of opinion that no gas manager should be without a supply of it during a severe frost.

Before leaving this part of the subject, I may tell you that I know of a place where a pipe had been laid upon the face of a pretty steep curve. Something went wrong with it, and as the parties were not aware what was the matter, the pipe was lifted—rather a serious operation when the frost had penetrated the ground to the extent of 30 inches. Had they only known how to have opened the ground at the top of the pipe, tapped it, and poured down a little methylated spirits, the evil would have been removed in a few minutes.

I suppose most of you have noticed in the newspapers that the Dumfries Gas Corporation have been mulct in £20, because of their inability to supply gas to a theatre for one night only. Perhaps I am wrong, but I suspect that it was the aqueous vapour of the gas frozen in the pipe that caused the accident, and not water as was supposed. Had water been in the service-pipe, it would have given warning by the lights jumping. I have another case in point. The main-pipe supplying the Bridge of Allan Railway Station was blocked up from a similar cause, but was cured by the use of spirits.

With reference to the service-pipes, I have to state that in Stirling a good many houses have sunk flats, and that the service-pipes for these are generally taken into the building beneath the stair and landing over the area to the front door. The whole of these pipes we generally found to be closed up, but with the assistance of the spirits we were able to keep them all free. However, some of them had to be operated upon twice, and one I remember on three different occasions during the storm. We have also had a good deal of trouble, from the same cause, with the upright pipes in the lamp-posts; but I am glad to be in a position to say that, with one exception, I was able to keep the whole of them, numbering about 300, going. Perhaps some of you may not be aware that in America, and especially in North America, the smallest pipe used for lamp-posts is ¾-inch—the extra size being required in consequence of the severe frost in that part of the world.

As to gas-meters, I suppose that most of you have received a copy of the celebrated tirade against Messrs. Warner and Cowan, entitled "Correct Gas Measurement," and addressed especially to the Directors, Engineers, and Shareholders of Gas Companies. The first paragraph of this pamphlet says that the want of gaslight caused by the freezing of wet meters is a very general source of complaint, and it is acknowledged that all attempts to remedy the evil have proved futile. This I emphatically deny. We have fully 4000 of these meters in use in Stirling, and throughout the last severe storm we were able to keep the whole of them going. Of course a small number of them got frozen, but by using spirits of wine, which I have found to be an efficacious cure, they can be easily protected. I find that a pint of spirits will keep a 3-light meter all right.

In conclusion, I trust that the results of my experience may prove of some little service to my brother Managers, and I can assure them that if such be the case, I shall feel amply repaid for the effort I have made in bringing this short paper before the Association.

Discussion.

Mr. Robb (Haddington): I think we ought to be obliged to Mr. Watson for bringing this subject before the Association. To those individuals who have to go out and look after meters his remarks are of immense consequence. To Managers like myself, who have the whole work to do in connection with the works, it is indeed something worth knowing that spirits of wine will keep a meter working during frosts such as we had last winter. It was so severe with us that many of the meters ceased to work, and, as I could not attend to them all, I told the people to attend to them themselves. I just allowed those who could not get gas to want it. Some got plumbers, and plumbers (as we all know) sometimes do stupid things; so they emptied the water out of the meters, and put in paraffin oil, and since then I have not been able to take a screw out without raising a dreadful smell. In fact, since this change has taken place the

houses in which this was done have smelt strongly of the oil. To introduce paraffin oil is one of the worst things possible, for it never gets out of the meter. Now, spirits of wine has a more pleasant smell than paraffin oil, and it is a much likelier thing to put into a meter. I think we ought to thank Mr. Watson for bringing the subject before us.

Mr. WHIMSTER (Perth): I think that we are indebted to Mr. Watson for bringing this matter before the meeting. It is a subject in which most of us have a deep interest. In Perth we are peculiarly situated in respect of gasholders. They are very much exposed to frost. The tanks are of iron, and stand 12 feet above the ground. A great many years ago—indeed, shortly after I entered upon duty in that city—I found some difficulty in keeping the gasholders free from ice. The method previously adopted was to chip the ice, strip the sides of the tank, and then to fish up the ice. During a very severe frost one year this process was going on, but the ice was being formed near the surface of the ground, and the guiding chains of the gasholder getting caught between the conducting rods and the tank, a very heavy and a very dangerous pressure was thrown upon it. This frost was not, however, of long duration, but it gave warning of what I might expect in more severe weather. The plan I adopted was a simple one, so far as gas-works that have a small steam-engine are concerned. I conducted the waste steam into the gasholder-tank, by means of a pipe having a bend upon it sufficient to immerse it in the water, with the bend half under and half above the water. The condensed steam was by this means allowed to flow into the gasholder at every stroke of the engine, and in a short time there was a circulation of the heated water round the gasholder. I was then able to remove the steam-pipes which are round the lute of the telescopic gasholder, and I have had perfect freedom from the effects of frost ever since. During the past winter there was not the slightest appearance of ice at any of our gasholders. With regard to meters, we have had our experience in that direction this winter as well as, I dare say, most managers, and it has been very stiff work, without employing extra hands, to keep the meters going. Like Mr. Watson, we have exerted ourselves to the utmost, and we have been pretty successful, though not always so. One thing I have discovered, and that is—if a meter is placed, say, 12 inches under ground, or under the surface of the surrounding ground, such as in an open cellar, it is perfectly protected against frost, even of the most severe kind, always provided you keep it away from draughts. If you can keep the meter also away from the outer wall in an inhabited house, so that the rime will not come in contact with the meter, it will be a protection to the meter. Our great difficulty is to get architects and landlords to allow us to put the meters where they should be placed. We have severe contests about this, but I have taken my stand, and said, "Well, I shall not place the meter there, and I shall not put the gas into a meter placed there;" and when it comes to that, the point has been yielded; but one does not like always to take one's stand on a point like that. Within the past 18 months two streets of houses have been built. In these houses we had the meters placed where we wanted them, and the result was that not a meter in the whole of those blocks was frozen last winter. There is another thing in connection with the freezing of meters that I think, perhaps, it would be valuable to gas managers to know. In condensing gas, it is important to keep the temperature as high as possible. I find that during the summer months, with the temperature of the atmosphere at 70°, I have the best results from the gas. I try to keep it up at the same temperature during the winter. I cannot altogether succeed in that, but I can generally get it from 60° to 70° after it leaves the exhauster, and before it is forced into the underground pipes to the purifiers. We keep the temperature pretty high, and we get it into the gasholder in that condition, and the gas is never down to the freezing point, or anything like it. It keeps the underground pipes in the street warm, and no meter will freeze within a mile of the gas-works. The temperature is aided by the condensed steam that is thrown into the gasholder-tank. The water in the gasholder is sensibly warm through the whole winter, and I keep it always going during the summer time as well. It does no harm.

Mr. HISLOP (Paisley): Like Mr. Whimster, I feel indebted to Mr. Watson for having brought up this subject. I may say that my experience very much coincides with his. I have used methylated spirits for a long time. I find that a quarter of a gill for a 1-light meter is about sufficient. Indeed, it is the only resource we have in a winter such as that through which we have just passed—namely, to supply consumers with a quantity of methylated spirits and advise shopkeepers and others, either by notices in the public papers or by circulars, what they ought to do. In this way the difficulty is very much overcome. In reference to gasholders, I find that new gasholders are very liable to be affected by the frost, for the simple reason that the water in the tank, and also in the lute, is not, as in old tanks, saturated with hydrocarbons, and is more liable to be affected by frost. I act somewhat after the manner of Mr. Whimster, and drive a current of water round the tank. I lead a hose of cold water up to the lute, and let the current in at the one side, and allow it to run over the telescopic gasholder. I find that is a great improvement, but I may say that the American practice has been to fix a malleable iron tube on the lute, and dip the end of it into water, and through this tube a jet of steam is kept up throughout the winter, when the severity of the frost continues, and that prevents freezing. The apparatus can be easily taken away in the summer time. Mr. Whimster's idea of heating gas is, perhaps, not a bad one, if the proper correction can be made for the difference in the volume. I believe if gas were sent out at something like 60° or 65° of temperature, we should have little to complain of in regard to the freezing of the lutes on our telescopic gasholders. The practice I have adopted is to surround the tank with heated water, and in that way the ice is separated from the iron, when the large pieces are carefully taken out, so as to leave the holder entirely free. I hold that unless the larger pieces of ice are entirely taken away, and the water thoroughly cleared out, in the space of an hour the whole thing will be fixed again as hard as ever.

Mr. M'GILCHRIST (Dumbarton): In common with the other speakers, I have to thank Mr. Watson for his paper. I may state that while I was an assistant with Mr. Hislop, at the Partick, Hillhead, and Maryhill Company's works, we largely used spirit of wine for the service-pipes, meters, and lamp stand-pipes, and we found it to do the work excellently. I never used it for wet meters, however, but we generally advised consumers by advertisement that they should, in exposed places, wrap their meters with woollen cloth, so as to prevent them from freezing. Mr. Watson's method of preserving the gasholder-tank against the effects of frost is a good one, but I am afraid it does not overcome the principal difficulty that we as gas managers have to deal with—namely, with respect to the lutes of telescopic holders.

Mr. WATSON: No; it does not refer to them at all.

Mr. M'GILCHRIST: Of course the lute is the place most likely to freeze, and consequently neither Mr. Watson's system nor that of Mr. Whimster will act. It would require some such contrivance as they have in America—namely, a steam-pipe right round the lute. Then in regard to Mr. Whimster's high temperature, it would be an excellent thing to maintain the temperature at 65° to the consumer's meter; but supposing we had it at 65° in the holder, when it goes through the pipes where the ground is freezing the temperature will be reduced, and a deposit of liquid made in them that would be much better deposited in the condensers in the works.

Mr. WHIMSTER: While it is fresh in my mind, I should like to say that Mr. M'Gilchrist has touched upon a topic to which I meant to refer. The water-traps near to the works, in certain conditions of the atmosphere, are filled with naphtha, or something like naphtha; but we do not throw that away. We bring it into the works, and put it into the tar-well. The lutes of the gasholder freezing was a thing that claimed my attention at the beginning. I was afraid that I should not succeed in preventing that. However, we have two telescopic gasholders at Perth, and I may mention that one is heavier than the other. When the lute comes down amongst the warm water in the tank, it naturally thaws before the other is lowered to the extent of its lute, and thus, in consequence of the heating of the water, no ice is formed.

Mr. MITCHELL (Coatbridge): It would be all very well if we were able to sell the gas some 3 or 3½ miles from the works at the temperature referred to. Last winter we were selling it at 28°, and, therefore, we were only paid 944 feet instead of 1000, which we would have been paid for had we sold it at 60°. That is a point on which I should like to hear some of those present speak. There is a great amount of leakage or unaccounted-for gas, which I do not think is due to carelessness, from the fact that the gas after leaving the station-meter becomes so contracted by the difference of the temperature. The loss, I think, occurs in that way. With reference to aqueous vapour in the gas, it is well known that gas at 60° contains 1·86 per cent. of moisture. Producing it at 40°, you have only one-half of the aqueous vapour, and that in another way has something to do with the unaccounted-for gas. I should be glad to hear on the subject any one who has considered this point of distribution.

Mr. M'GILLIVRAY (Penicuik): I have had some experience in this matter. The winter before last I put a steam-pipe under the condenser, and the consequence was that the gas was kept at a uniform temperature of from 50° to 60° at the station-meter, and at 40° to the consumer, and the leakage was 23½ per cent. Last winter was a very severe one. We allowed the gas to pass the station-meter at the low temperature of from 25° to 35°, and we sold to the consumers at about the same temperature. No artificial means were used to elevate the temperature, and our leakage account was 9¾ per cent. This shows that, if we raise the temperature of the gas before being measured at the station-meter, we increase our leakage account, unless we can keep it up the whole way.

Mr. WHIMSTER: As the temperature of the gas supplied has been taken special notice of, I may say that, although we have endeavoured to keep up the temperature, our leakage does not show the results generally anticipated. It is quite possible that the temperature might be very largely maintained up to the point of delivery into the consumer's meter. And it is natural that it should be so, because, as a rule, the pipes in the streets are too deep for the frost to affect them, and they are kept at a high temperature by the gas constantly passing through them, so that there is no likelihood that they will go down to the freezing point, or anything like it. I may say that our leakage is under 10 per cent., so there cannot be much loss in that direction.

Mr. MITCHELL (Coatbridge): There may be a difference in the ground, and I know in my district the frost last winter extended to 3 feet. Last year I opened a main 23 inches below the surface of the road, and it was so encrusted with the frost that it was dangerous to search for the leakage. On one occasion I was looking after the leakage in a 7-inch pipe crossing a bridge, and the frost was so hard, and the pipe so firmly encrusted, that a spark was struck by one of the men's picks, and an explosion ensued. This shows that the temperature of the gas at the holder is not maintained to any distance from the works.

Mr. WATSON: I have to thank you for the kind way in which you have received the paper. I quite concur in the remarks of Mr. Whimster as to the placing of the meters. For my own satisfaction, I have five or six meters for measuring the gas consumed by the public lamps and the whole of these were so protected by the surrounding earth that the frost did not reach them. We have a telescopic gasholder in Stirling, but I did not follow the same course with it as with the others. Before the next winter I expect to have a boiler and a supply of steam.

The PRESIDENT: I am sure we are all very much obliged to Mr. Watson for bringing this very practical subject before us, and if we should be so unfortunate as to have another winter as severe as the last, I am sure we shall all know better what to do.

Mr. W. YOUNG (Clippens) read a paper

ON THE ELIMINATION OF SULPHUR COMPOUNDS FROM ILLUMINATING GAS.

It will possibly be in the recollection of most members present that, on the occasion of the meeting of this Association in 1876, I had the honour of reading before them a paper on the utilization of waste shale gas. Amongst other modes in which it could be utilized, I referred to the condensation into a liquid form of the volatile hydrocarbons diffused through such gas. This liquid would represent 80 per cent. of the total light-giving constituents in shale gas, could be easily transported, and, from its low boiling point, could be readily diffused through a poor gas for the purpose of conferring upon it increased illuminating power. I further drew your attention to the remarkable affinity for sulphur compounds possessed by the volatile fluid recovered from the gas.

To-day I propose to resume that subject, more particularly with the view of showing you that this fluid is not only a valuable carburetting agent, and at a comparatively trifling cost increases the illuminating power of a poor gas, but that it may also be made a valuable purifying agent for the removal of those sulphur compounds which are insoluble in water, and which at present are removed only in part, and that at great expense and with considerable difficulty.

The processes hitherto adopted for the removal from coal gas of these sulphur compounds may be divided into two classes—that in which they are removed by chemical affinity, or by causing them to combine with a substance having an affinity for them, such as by passing ammoniacal gas in a caustic state into the coal gas in the hydraulic, and subjecting the whole to condensation; or, secondly, by using the hydrosulphide of one of the alkalies or alkaline earths. Hydrosulphide of lime has hitherto had the preference, and is employed, as you are aware, in the ordinary dry lime purifiers.

By the second class of processes the sulphur compounds are decomposed by heat, either in the presence of water vapour or hydrogen gas, the sulphur present being in both cases converted into sulphuretted hydrogen, which is removed either by lime or by hydrated oxide of iron.

The second class of processes failed in practice, from the difficulty of heating and cooling such large volumes of gas, and the reason why the first is not so successful as it might be is explained by Dr. Odling, in his lecture on "Sulphide of Carbon," delivered before the British Association of Gas Managers in 1872, in a far more perfect and condensed manner than is possible for me. I shall, therefore, take the liberty of reading to you the following extract from that most interesting lecture. He says:

"I am now about to call your attention to the relationship subsisting between disulphide of carbon (CS_2) and carbonic acid gas (CO_2). You

know that when ordinary limestone is strongly heated, it breaks up into carbonic acid gas or oxide of carbon, and caustic lime or oxide of calcium

$$CaCO_3 = CaO + CO_2.$$

But practically, at any rate, you cannot reproduce limestone or chalk by bringing together its constituents in the anhydrous (dry) state. Instead of quicklime, you have to use slaked lime or hydrate of calcium, and even then the action takes place but slowly, unless you facilitate it by employing your slaked lime in a slightly moistened condition. And this is only one instance out of many of the advantage, or even in some cases the necessity, of the intervention of moisture, where a soluble gas and a solid are required to act upon each other. Thus, with dry air and dry iron, there is entire freedom from rusting; but with the surface of the iron moistened, an absorption of the oxygen of the air takes place, and rust is very quickly produced. But in respect of the removal of disulphide of carbon from coal gas by means of any chemical absorbent, owing to the insolubility in water of the disulphide, we gain nothing—probably we lose something—by employing our absorbent moist; or we have to forego, in the case of the difficultly removable sulphide of carbon, the advantages we are so glad to avail ourselves of in the case of the readily removable carbonic acid and ammonia. And, of course, this insolubility of the disulphide in water interferes very seriously with the removal of its vapour by means of absorbents dissolved in water, and used in scrubbers or wet purifiers, as I have, indeed, already remarked. But despite the difficulty consequent on its insolubility in water, there are agents capable of removing sulphide of carbon from coal gas, provided the gas is allowed to remain in contact with them for a sufficient length of time.

"I would remind you, again, of the analogy subsisting between sulphur and oxygen. You know, for instance, that chalk is called by chemists carbonate or oxicarbonate of calcium ($CaCO_3$). Now, there exists another compound called by chemists sulphocarbonate of calcium ($CaCS_3$); and just as chalk or oxicarbonate of calcium is capable of being produced by the action of carbonic acid gas (CO_2) on hydrate or oxihydrate of calcium (CaO, H_2O)—fresh slaked lime—so is sulphocarbonate of calcium capable of being produced by the action of sulphide of carbon (CS_2) on sulphydrate of calcium (CaS, H_2S), the chief constituent of half foul gas lime—

$$CaO, H_2O + CO_2 = CaO, CO_2 \text{ or } CaCO_3 + H_2O.$$
$$CaS, H_2S + CS_2 = CaS, CS_2 \text{ or } CaCS_3 + H_2S.$$

"Gas lime, i.e., in a particular state of foulness, to which I shall refer more particularly in a minute or two, has the property of absorbing sulphide of carbon, much as slaked lime has the property of absorbing carbonic acid; though even under the most favourable circumstances the action is far more sluggish, and though, in practice, the circumstances never are so favourable, owing to our not deriving, in the case of the disulphide, that advantage from the employment of a moist absorbent that we are accustomed to avail ourselves of in the case of carbonic acid. Further, just as carbonic acid may be absorbed equally well by some other hydrated alkali instead of by hydrated lime, so may disulphide of carbon be equally well absorbed by some other sulphydrated alkali instead of by sulphydrated lime. But it is obvious that the only sulphydrated alkali that can at all compete in point of cheapness with sulphydrated lime, is the sulphydrated ammonia always existing to some extent, and capable of being accumulated to a large extent, in gas liquor. Sulphide of carbon, then, combines with sulphydrate of ammonia ($NH_3 H_2S$)—more conveniently regarded as sulphydrate of ammonium (NH_4) HS—to form the body sulphocarbonate of ammonium $(NH_4)_2 CS_3$, analogous to sulphocarbonate of calcium ($CaCS_3$), or, more strictly, to sulphocarbonate of potassium (K_2CS_3)—two proportions of ammonium or potassium being equivalent to one proportion of calcium."

Dr. Odling here clearly points to the fact that to enable us to deal with sulphide of carbon in the same manner as with carbonic acid and sulphuretted hydrogen, we would require a liquid which would dissolve the sulphide of carbon vapour, and wet the surface of the chemical absorbent, and thus serve as a medium to bring about a union, in a manner analogous to the water, which freely absorbs carbonic acid and sulphuretted hydrogen, and transfers it to the alkaline lime.

A second extract points still more clearly to the necessity of having a solvent for sulphide of carbon to enable it to enter into chemical combination with a substance having an affinity for it. He says:

"If we take an aqueous solution of potash or ammonia, and agitate some disulphide of carbon therewith, the sulphide of carbon, being insoluble in the water, is almost unaffected by the dissolved alkali, with which, indeed, it is scarcely brought into contact. But if instead of an aqueous we take an alcoholic solution of potash or ammonia, in which the disulphide dissolves readily, by the act of solution every particle of it is brought into contact with, and is acted on by the dissolved alkali. And, indeed, if alcohol were as little costly as water, we should find no great difficulty in dealing with the sulphide of carbon contained in our coal gas." "Now, just as there is a difficulty in removing sulphide of carbon vapour from coal gas by condensation, so also is there a difficulty in removing it by washing. Indeed, it is so insoluble in water that we have no chance whatever of effecting its removal by scrubbing the gas with water." "But sulphide of carbon, though insoluble in water, is capable of mixing in all proportions with alcohol and ether. If I pour into this cylinder of alcohol some disulphide of carbon, the greater part of it disappears before reaching the bottom, and the whole of it disappears after a moment's agitation. This solubility of the disulphide in alcohol is taken advantage of by chemists when they wish to subject it to the action of chemical agents, and more particularly to the action of alkalies."

Now, I am of opinion that in this volatile fluid we have exactly what is indicated as required by Dr. Odling, to enable us to free our gas from sulphur compounds; for, as I shall endeavour to show you, it possesses both the power of dissolving sulphide of carbon vapour very freely, as also the power of dissolving ammoniacal gas, in a similar way to alcohol. It has further this advantage, that it is low in price, and that the portion which must from its volatility pass away with the gas, serves as an enricher or improver of the illuminating power.

I have here a test-tube such as is used for testing the condensation by bromine, the bulb of which I will fill with the gas supplied to the room. I will now add a little sulphide of carbon, and shake or mingle the gas and it together. The vapours of the sulphide of carbon are thereby diffused through the gas, and you observe that on removing my finger the water is considerably depressed in the tube, due to the increase in volume from the diffusion of sulphide of carbon vapours. I will now add a little of this volatile fluid recovered from the waste shale gases, and shake the whole together, thereby bringing the sulphide of carbon vapour into contact with the fluid. On removing my finger under water, you see that it immediately rushes into the tube, and the gas assumes nearly its original volume. I say nearly, for the volatile fluid itself has given off some vapour, but the difference is solely due to the vapour of the hydrocarbon fluid, and not to the sulphide of carbon remaining; but that the vapours of the latter are entirely absorbed is proved by filling the bulb of this second tube, which is similar to the first, with the same gas, when you see that on adding the volatile fluid from the waste shale gases, and shaking as before, both have the same volume. This vapour, however, as I have already indicated, would not be lost, but would have this effect, that the illuminating power of the gas would be increased at a smaller cost than from any other source; and were it desirable to employ such a hydrocarbon fluid as would not, or only appreciably volatilize into the gas, such a hydrocarbon can be easily obtained at a very low price.

We see, then, that this fluid has the power of dissolving sulphide of carbon vapours. Let us now see how it behaves with ammoniacal gas.

I have here a strong solution of ammoniacal gas in water. I will pour over it a quantity of the fluid hydrocarbon, and shake the two together. The water and fluid, not being miscible with each other, separate at once on standing. I will now decant a portion of the hydrocarbon fluid, and pass it through the filter paper, to free it from any mechanically suspended matters. Now you all know the affinity of water for ammonia, yet you see that this hydrocarbon fluid has been able to deprive the water of a portion of its ammonia, notwithstanding its affinity for that substance; for it at once gives evidence of the presence of ammonia on this turmeric paper by changing it brown, and this red solution of litmus, blue. I have here also a dilute solution of sulphuric acid of such strength as is used for testing alkalies. I will add some of it to the ammoniacal fluid. You will observe that it takes some considerable quantity of the acid solution to neutralize it and change the litmus again red. The quantity of the ammoniacal gas which this fluid can dissolve from such an aqueous solution of ammonia I have found to be about twice its own volume. We have, therefore, in this ammoniacal hydrocarbon fluid a substance which would both readily dissolve the sulphide of carbon in the gas, and also combine with it.

With reference to the modes in which such a hydrocarbon solution of ammonia might be applied, I need scarcely make mention of them, as there are such a number of ways which will suggest themselves to you—such as using one of the ordinary scrubbers through which to pass the solution; or the solution might be used in an ordinary wash-vessel, when such would be available; but in practice I am of opinion that it would be best applied after the gas had undergone purification from carbonic acid, as this gas would combine with the ammonia to form the oxycarbonate, to the exclusion of the sulphide of carbon. The separation of the sulphocarbonate of ammonia found in the solution of hydrocarbon fluid can be readily effected by simply bringing it into contact with water, which would dissolve it out; and as the fluid is much lighter than water, it rises to the surface, and can be easily decanted, to be again re-saturated with ammoniacal gas, to be re-employed for further testing the gas.

As you are aware, the affinity of simple hydrated alkalies for sulphide of carbon is not nearly so great as for the alkalies after being united with sulphuretted hydrogen to form hydrosulphide of the alkalies. Now it so happens that this fluid also freely dissolves hydrosulphuric acid. I have here a portion of the fluid saturated with that gas. You see that on commingling it with the salt of lead in this test-tube, the black sulphide of the metal is at once formed, and in great abundance. I will now mingle the ammoniacal solution with the hydrosulphide solution, when there is at once a combination between the alkalies and the acid gases in solution. You observe that there is no evolution of gas, but that both gases, although combining to form a salt, remain in solution. Therefore we have here the hydrocarbon holding in solution hydrosulphide of ammonia, which acts more energetically upon the sulphide of carbon vapour present in coal gas.

The hydrosulphides of the alkalies and alkaline earths are not soluble in this hydrocarbon fluid recovered from the gas, and therefore we cannot form a solution with lime or soda as we can do with the ammoniacal gas; but chemistry teaches us that although it is an advantage, in all cases it is not necessary that the fluid employed for bringing about a union between a gas and a solid, or between a solution of a chemical and a gas, be a solvent for both. In the great majority of cases it is found more important that the fluid be such as to dissolve the gas and reduce it to the liquid state, as in this state it can readily combine with another liquid holding in solution the chemical substance with which it is desired to combine the gas, or the solid substance being melted with the solvent of the gas, it acts as the medium for reducing the gas into a liquid, and transferring it to the solid, with which it may enter into combination and assume the solid form.

Now at present, as you know, hydrosulphate of lime is almost universally employed when the sulphur compounds are removed from the gas. It will be evident to you, therefore, that to wet the lime compound with this fluid would have the effect of bringing about a rapid union between the sulphur compounds and the lime salt, as the fluid would dissolve the sulphide of carbon present in the gas in the gaseous or vaporous form, converting it into the liquid form, and bringing it into such close contact with the hydrosulphate of lime that the chemical affinity would come into action, and the sulphide would combine with the lime salt to form the carbosulphide of calcium. The wetting of the hydrosulphide of lime could be accomplished by spraying the fluid through the gas as it enters the purifier by a jet of compressed gas, or the fluid might be sprinkled over the hydrosulphide of lime by a pipe passing through the purifier-cover.

Should it be desired to employ the hydrosulphide of soda in place of lime, then that salt, being soluble in water, could be used as a watering solution combined or mingled with the hydrocarbon fluid, and the whole pumped through an ordinary scrubber. When the hydrosulphide of soda got saturated with sulphide of carbon, it could be separated from the fluid, and the sulphide of carbon recovered by adding a strong acid to the soda salt.

But gas contains many other substances having sulphur in their composition besides sulphide of carbon, and which the hydrosulphide of the alkalies does not remove, but which this hydrocarbon removes readily. This fact has been observed long ago, for when a hydrocarbon fluid was employed for carburetting the gas used in street-lamps in London, it was observed that however pure the fluid hydrocarbon might be from sulphur compounds, when put into the lamp to be carburetted there was always left a dark residue having a most abominable smell, and which when distilled gave evidence by lead paper that it contained sulphur in its constitution. And you have all seen the hydrocarbon fluid which collects in drip-boxes, and on the surface of the water in gasholder-tanks, which, as you know, has a most offensive smell, and which contains sulphur in its constitution.

Just, then, as we at present employ water to absorb ammonia from our gas, so we might also employ this or a similar hydrocarbon fluid for the absorption of those sulphur compounds which escape other modes of purification. So soon as this fluid approaches saturation with sulphur compounds, it would become necessary to treat them for their elimination, either by fractionally distilling them, and removing the portion containing the sulphur compounds, or by simply distilling, and treating the distillate with suitable chemicals (acid and alkalies), or by distilling them and subjecting them to the vapour of water or hydrogen gas at such a temperature as would bring about their decomposition; which would, to all intents and purposes, be a modification of the second set of processes referred to in the early part of this paper, and which would be practicable from the small quantity of vapour requiring treatment, compared with the gas from which the sulphur compounds were derived.

All the hydrocarbons, such as those distilled from wood, tar, crude or palm pitch, bitumen, and coal tar, have the property of absorbing those sulphur compounds; but there is none of them possessing so many necessary characters as this fluid, or analogous fluids derived from petroleum. First and primarily, these are lower in price, the present cost being 3½d. or 4d. per gallon; secondly, they are largely composed of paraffin and other hydrocarbons, which are not themselves acted upon readily by such chemicals as might be employed for the elimination of sulphur compounds; and, thirdly, they can be had in large quantities.

However, should this mode of purification be practically adopted, and any difficulty experienced in obtaining a supply of hydrocarbon fluid, the naphthas distilled from the tar could be easily employed, thus affording another proof that in the crude gas itself we have present all the materials necessary for its complete purification. Thus we have the tar to remove sooty matters; and, when properly applied, the water would remove every trace of ammonia; the ammonia, all carbonic acid and sulphuretted hydrogen; and the naphthas, the other sulphur compounds—thus providing a gas which would, so far as the noxious products of combustion are concerned, be as unobjectionable as, if not more so than the electric light.

Discussion.

Mr. HISLOP (Paisley): I have listened with the intensest pleasure to the paper we have just heard from Mr. Young. All the members of this Association, as well as myself, are, I am sure, always satisfied when they see Mr. Young's name on the programme, for we are certain we shall have a treat. To-day we have not been disappointed in this respect. The subject which he has so ably handled is one of great interest indeed—more so to our friends across the Border than to us in Scotland, where we are not so much troubled with bisulphide of carbon; but, at the same time, I think that his paper is a very valuable contribution to the science of gas manufacture, and I am sure we all feel very greatly indebted to him for it. No doubt the commercial value of the agent by which the process of removing the bisulphide of carbon is to be performed will vary at different times, and it will be a matter for those who are more immediately interested in it to consider whether it is not worth their while to go to the cost of this material, with the object of removing this much complained-of impurity. I move a hearty vote of thanks to Mr. Young for his paper.

Mr. M'GILCHRIST: I would also thank Mr. Young for his excellent paper; but there is a question or two which I should like to ask before the subject is passed over. I do not see that Mr. Young has at all clearly brought out certain points in reference to the use of this volatile hydrocarbon. For instance, seeing that the hydrocarbon fluid and the bisulphide of carbon are volatile, would they not both volatilize together and pass away with the gas? And again, would this hydrocarbon fluid not have an affinity for the hydrocarbons that are in the coal gas, and take them down in the shape of liquid along with the bisulphide of carbon, rather than allow them to get away in a gaseous state? These are questions which I should like Mr. Young to answer, seeing that on the occasion of one of our meetings some two or three years ago, he showed by experiment that the heavy hydrocarbons took down the light hydrocarbons. It seems to me that they would have the same effect here. Either Mr. Young was wrong when he spoke before, or he is wrong now. The two statements seem to me to be contradictory.

Mr. AITKEN (Falkirk): I have to say that this question of the purification of gas from bisulphide of carbon occupied my attention last year, and I made a great number of experiments all tending in the same direction as Mr. Young has shown to-day; but these were interrupted during the fall of last year by sulphur in another quarter, and I have not been able to get anything done to it since. I cannot say that my experiments were quite so successful as Mr. Young's have been. One thing I was very clear about, that lime did not take out the bisulphide to the extent that is supposed by our friends on the other side of the Border. Indeed, if it does so, it is only to a very limited extent. One of the points that I really wanted to work out further in the same direction was not to bring in anything from outside oil-works to accomplish the purification, but to manage to do all the work inside—to make the means of purification on the premises. It was at this point that I was interrupted.

Mr. YOUNG: Mr. M'Gilchrist has asked two questions. First, he says, seeing that both the hydrocarbon fluid and the sulphide of carbon are volatile, and that the sulphide of carbon present in coal gas is in the vaporous or gaseous state, would the volatile hydrocarbon remove it? And if it were absorbed or removed by the fluid, would it not have a tendency to re-volatilize into the gas along with the hydrocarbon fluid? I do not think so; at least, not if proper precautions were taken in the application of the fluid; and the danger referred to could only occur when the fluid was employed as a simple absorbent, and without the simultaneous application of chemicals. For instance, the ammonia present in coal gas is, as you are well aware, the vapour of a very volatile fluid, only condensing to a liquid at a temperature 40° or 50° below zero, and yet we cannot remove every trace of that compound from our gas by the judicious application of water, another volatile fluid boiling at 212° Fahr. Of course, we know that, in order to free our gas from ammonia, care must be taken in the manner in which the water is applied; that is, that it be employed in a succession of scrubbers, or in one very tall one, the pure water being made to act upon the nearly pure gas in the last or upper portion of the tall scrubber, and the partially fouled water employed to remove the ammonia from the gas as it enters the scrubbers. No doubt, were we to bring the fouled water as it leaves the scrubbers into contact with the pure gas as it leaves the same, the ammonia would re-volatilize into, and again contaminate the gas; or, if the water employed to absorb the ammonia were allowed to rise in temperature, it would either not so perfectly remove the ammonia, or the ammonia which it had previously absorbed would be re-volatilized. In a similar way it would be necessary, in applying this hydrocarbon fluid for the removal of the sulphur compounds, to employ it in such a manner as to bring the pure fluid into contact with the nearly pure gas, and the partially fouled fluid into contact with the crude gas; and it would be further necessary, as far as possible, to guard against sudden changes of temperature, because this would not only cause differences in the rate of absorption of the sulphur compounds, but would also bring about differences in the illuminating power of the gas due to variations in the amount of vapour of the fluid diffused through the gas. As I have shown you to-day, however, this fluid can be employed not only as a mere absorbent of the sulphur compounds from coal gas, just as water is employed for the removal of ammonia, but it can also be employed as the medium of bringing the sulphur compounds, and the chemicals having an affinity for these compounds, into such intimate contact as to cause them to unite, which would prevent all possibility of re-volatilization into the gas. Then in regard to Mr. M'Gilchrist's second question—Will not this fluid not only remove sulphur compounds, but also lead to the condensation of the hydrocarbons usually diffused through coal gas?—paradoxical though it may appear, there is no doubt that this fluid at first both absorbs hydrocarbons and sulphur compounds from the gas, but at the same time it gives up to the gas a portion of its own vapour; for the same cause which leads to the absorption of the sulphur compounds leads also to the absorption of hydrocarbon compounds which are soluble in, but different in structure from the hydrocarbons contained in the liquid. At one of our Association meetings—I think in Musselburgh—I drew attention to the fact that a spirit or a hydrocarbon fluid of a certain specific gravity had this effect when brought into contact with illuminating gas—that at low temperatures it lowered the illuminating power, and that, on the other hand, at high temperatures it increased the illuminating power; but, in reality, when first brought into contact with the gas, in both cases it absorbed hydrocarbons therefrom, only that at low temperatures it absorbed more of the hydrocarbon vapours, thus causing a reduction of the illuminating power. At high temperatures, on the other hand, the reverse was the case, more vapour of the fluid being volatilized than was absorbed. This, however, takes place only for a short time, for the pressure of the large quantity of hydrocarbons soon brings about a balance of the vapour tensions of the hydrocarbons—both of those usually present in the coal gas, and of the fluid hydrocarbon employed; but the sulphur compounds being present only in infinitesimal quantities, the balance of affinities would not be brought about until the hydrocarbon fluid was nearly all volatilized, and it would therefore continue to absorb the sulphur compounds long after it had ceased to have any effect upon the hydrocarbons present in the gas, and such hydrocarbons as would be absorbed from the gas would be all re-diffused through it, after the sulphur compounds had been separated, either by distillation or by chemical treatment, or they could be otherwise utilized as solvents for other purposes. When, at some of our other meetings, I referred to the removal of the hydrocarbon compounds from coal gas, and the consequent reduction of the illuminating power, I showed that the heavy or dead oils are the hydrocarbon fluids possessing this form in the highest degree, and that the tars or other denser oils which had so acted upon the gas, and deteriorated its illuminating power, were removed direct to the tar-well without any opportunity being afforded for the re-volatilization of the absorbed hydrocarbons back into the gas. In short, I showed that a volatile hydrocarbon fluid was diffused as vapour through a gas when brought into contact with it; but that, when a denser or less volatile fluid was employed, the hydrocarbons were absorbed or removed from the gas. Then in reference to remarks made by Mr. Aitken, anent the action of the hydrosulphide of lime upon the sulphide of carbon, there can be no doubt whatever about the chemical fact, that on bringing the vapours of sulphide of carbon into contact with hydrosulphide of lime, a union takes place; but perhaps the lime employed by Mr. Aitken in his experiments had been wet, which (as Dr. Odling, in the quotation which I have read to-day, shows) retards or prevents the union of the sulphide of carbon with the lime compound. But if the hydrosulphide of lime had been wetted with this fluid, instead of with water, he would have found that the sulphide of carbon would have been removed, and combined with the lime salt to form the sulpho-carbonate of lime. In the Clippens works we remove nearly all the illuminating power from our waste shale gases by dissolving out the vapours with heavy oils, in the manner which I have had the pleasure of describing to you at our previous meetings. We, however, require a portion of the gas for illuminating the works, and for use in the laboratory; and in order to fit it for such purposes, it is necessary that the sulphur compounds be removed from it by the ordinary process of purification, and that illuminating power be conferred upon it by diffusing through it a portion of the vapours of the hydrocarbons previously removed by the heavy oil. A very convenient means of carburetting the gas was found to be by pouring through the plug of the purifiers a portion of this fluid upon the purifying material. Upon removing this purifying material, after having been thus treated with the fluid, we found that it contained many other sulphur compounds than sulphuretted hydrogen, possessing a most abominable smell; so much so, indeed, that the men would rather come into contact with anything in the works than this purifying material when containing these abominably smelling compounds. Some years ago the idea suggested itself to me of increasing the efficiency of the ammonia refrigerating machine by employing the ammoniacal gas after leaving the expander in the refrigerating chamber, and on its passage to be absorbed by water, in order to bring about a further amount of cold, by passing through a vessel filled with a very volatile portion of this fluid. By these means I expected that the fluid would be diffused through the ammoniacal gas, and that when that gas was condensed by absorption with water, the volatile fluid would also be condensed; or that, in other words, the tension of both would be simultaneously reduced, and so bring about their liquification. I was surprised, however, to find that, instead of cold being at first produced on the passage of ammonia through the liquid, there was evolved a considerable amount of sensible heat, this being due to the absorption of the ammoniacal gas by the hydrocarbon fluid, and thus I observed that this fluid had the power of dissolving ammoniacal gas. Last year, when Mr. Aitken was experimenting upon the removal of sulphide of carbon by means of the tars, he and I had frequent conversations on the subject; and I believe that those conversations, along with the other suggestions which I have just enumerated, together with the reading of Dr. Odling's lecture, and the difficulty of finding a market for this product, led me to give the matter closer attention; and although, of course, the process has not yet had any practical application, I have thought it advisable to bring the subject before you, for I am of opinion that it is most desirable that all such matters should be brought as early as possible under the consideration of such Associations as this, for thereby many minds are brought to bear upon it, and if there is anything in it, it makes much more speedy progress to perfection than would be possible when confined to one mind, and thus leads to the ultimate good of every one.

A hearty vote of thanks was accorded to Mr. Young for his valuable paper.

(To be continued.)

IMPROVED PUBLIC LIGHTING BY GAS IN PARIS.—The Place du Château d'Eau has just been furnished with improved gas lamps and burners similar to those employed by the Paris Gas Company for the lighting of the Rue du Quatre Septembre. There are 22 large and 54 small burners, the consumption of the former being 50 cubic feet, that of the latter 30·5 cubic feet per hour. The amount of light produced by each is equal to 125 candles and 85 candles respectively, and the effect produced is exceedingly beautiful. The area now selected for the Company's experiments in improved public illumination in competition with the electric light is of greater extent than the thoroughfare in which their operations were first conducted, and, consequently, the effect produced is somewhat less intense. Nevertheless the Company have achieved an undoubted success, which certainly justifies the hope that at the Halles Centrales—the only remaining locality allotted to the Company by the Municipality for conducting their experiments—the improved lighting by means of gas will surpass all expectations. The original intention of the Municipality was to improve the lighting of the Place du Château d'Eau by placing upon it 26 electric lamps, which would have cost 12s. 6d. an hour, and furnished the light of about 3000 candles. The Paris Gas Company thereupon proposed to light the area with their new burners, the result being the production of a light equal to about 7500 candles, at the cost of 9s. 4d. an hour. To produce an equal illumination by electricity would, it is calculated, cost 30s. an hour.

A NEW HIGH-POWER GAS-BURNER FOR HARBOUR LIGHTING.*

By Mons. D. Gautier, Manager of the Havre Station of the European Gas Company.

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[Translated from *Le Gaz.*]

About the month of November, 1878, I received an intimation from the Engineers of the Ponts et Chaussées that some trials of the Jablochkoff system of electric lighting were to be commenced in the following month upon a portion of the port of Havre, in accordance with instructions emanating from the superior authority, who had voted a special sum for the purpose.

Mons. Quinette de Rochemont, the Engineer of the Ponts et Chaussées, before whom I was requested to attend, intimated that the European Gas Company should, on their part, undertake some comparative trials, in order that they might ascertain whether it would be possible, by means of gas, to light the port of Havre more efficiently, and thereby render access to it at night, at the time of high water, less difficult for vessels.

At that period there was in existence only one burner of large consumption capable of furnishing anything like the luminous intensity produced by the electric light, and that was the burner of Mr. Sugg, an English maker of great merit. This was, therefore, examined by us, conjointly with the Administration of the Ponts et Chaussées. In order to bring this burner into use, however, it was necessary to employ glass chimneys, and this rendered its application almost impossible at Havre, where high winds and changes of temperature are so frequent. Consequently, its maintenance would have been too costly, and, furthermore, the Engineers of the Ponts et Chaussées did not consider the power of the burner sufficiently high to allow of its advantageous employment in this particular case. It was, therefore, necessary to find out by what means to obtain a burner capable of giving a light equal to from 15 to 20 Carcels (150 to 200 candles); but the greatest difficulty was the attaining of that end without the employment of a glass chimney.

After making a number of investigations, which occupied me till nearly the middle of December, I applied myself to perfecting a new kind of burner I had thought of, as well as a special form of lamp. Repeated experiments made in the presence of M. Delanne, principal director of the Ponts et Chaussées, whose hearty co-operation was never once wanting, had already taken place at our works, and appeared to give entire satisfaction, when we learnt that the Paris Gas Company had decided on entering into competition with electricity, and that several manufacturers in the city were exercising their ingenuity to the utmost in order to produce burners of high illuminating power. A journey to Paris was projected, with the object of ascertaining what were the improvements that had been effected in this direction, for it appeared to me to be useless to continue the investigations commenced at Havre, if at Paris were to be found burners of high power with naked flames. At that time M. Giraud was working at the construction of a burner of tolerably large capacity for use in a glass lamp. M. Lepaute, so well known for his remarkable clock-work productions, and for the improvements he has introduced into the illumination of lighthouses, had also been much occupied with the question, having been engaged in perfecting a triple-ring burner which he had devised as long previously as the year 1869, and which he was very desirous of trying himself at Havre in the course of January. This burner was furnished with a chimney. In the same month I received from M. Maldant a naked-flame burner; but it was of too low a power to attain the end we were seeking. In the course of a visit to M. Bengel, the gas apparatus manufacturer of Paris, there were shown to us some slit burners so arranged as to allow two flames to be brought in contact one with the other at will. The illuminating power was thus higher than that afforded by the two burners when separated, the cause being attributable to the increase of temperature, which rendered combustion more complete.

From the commencement of our investigations our attention was equally directed to slit burners, arranged either upon the same line, or else in such a manner that all the flames converged towards a common centre. In fact, a row of twelve slit burners had been fitted up in the yard of the works, and placed in a lamp of suitable proportions. The effect produced was fairly satisfactory, but these arrangements had this inconvenience connected with them, that they showed certain gaps between the burners, and presented blue portions at the bases of the flames; furthermore, when tested by the photometer, they did not offer advantages sufficiently striking to allow of their application.

These different trials not having produced the desired results, I again set to work in the hope of overcoming the difficulties I should meet with in using, without a glass chimney, a burner arranged for a consumption exceeding one cubic mètre (35 cubic feet) of gas.

I shall not attempt to describe all the experiments tried, as that would necessitate my entering into too many details. I will simply say that my investigations were confined to obtaining the most perfect combustion under the best possible conditions—viz., (1) to burn the gas at the lowest pressure; (2) to keep the flames as long as possible in contact with the air; (3) to study the diameter most suitable for the holes of the burners; (4) to find the most convenient space to allow between each burner; (5) to raise the temperature by the junction of the flames at their extremities, in order to prevent the escape of certain particles unconsumed; (6) to arrange a supply of air in proportion to the consumption. These several points were successively considered, and the object in view was at length attained by means of a burner having a series of horizontal jets. A description of this burner follows.

In the arrangement adopted, the gas first of all enters a box, and is distributed into a ring by means of four supply-pipes; a second ring, smaller and more raised than the first, is supplied by a single pipe, also connected with the before-mentioned box, and this pipe divides into two branches before its junction with the second ring. A tap is placed upon the pipe supplying the second ring, for the purpose of regulating the size of the flames in the event of a chimney of metal or any other material, with or without an interior cone, being employed. This chimney is placed at a certain distance above the burner.

Whatever may be the size of the burner, all the jets—to the number of 80 for burners consuming 1600 litres (56·5 cubic feet)—are pierced laterally and exteriorly to the periphery of the two rings. A pressure of from 13 to 14 millimètres (5 to 5½ tenths) kept up in the principal supply-pipes is quite sufficient for the proper working of these burners.

Under such conditions a most advantageous consumption was obtained with an expenditure of 1500 to 1600 litres (53 to 56·5 cubic feet) of gas per hour. Above this figure the results shown are not so good; consequently, there is a certain limit of consumption which must not be exceeded. Burners consuming from 500 litres (17·5 cubic feet) per hour are constructed upon exactly the same principle.

I was anxious to ascertain exactly what advantages would result from burning gas in a medium the temperature of which had been raised, and for this purpose I made the following experiment. The exterior temperature was 5° C. In an apartment closed as hermetically as possible was arranged a photometer provided with a burner having a glass chimney, giving a flame of a size corresponding to a consumption of 105 litres (3·7 cubic feet) of gas. In order to obtain a temperature more and more elevated, a fire was made and a gas-burner having an ordinary chimney was lighted. In proportion as the temperature of the apartment became higher, as ascertained by means of a mercurial thermometer, it was found to be necessary to decrease the height of the flame of the burner with the ordinary chimney as well as that on the photometer. The consumption of the latter was not only not more than 105 litres (3·7 cubic feet) at the conclusion of the experiment, but simply 70 litres (2·5 cubic feet) to give the lighting power of one Carcel (about 9·6 candles). The air in the apartment having been quickly restored to the outside temperature, the flame of each burner was observed to diminish considerably, and it was after this experiment had been made that the adoption of lamps as firmly closed as possible was decided upon.

Samples of lamps of various shapes have been constructed specially for this kind of burner, the glazing in each being so arranged as to allow for the expansion of the glass, as well as for cleaning and repairs. The upper portions of the lamps are so made that the current of hot air coming from the metal chimney produces in a certain sense a vacuum in the interior of the lamp, and eliminates a portion of the heat there concentrated, at the same time establishing a current between the burner and the glass of the lamp. The upper part of the metallic chimney is furnished with a perforated covering, an inner cone of which serves to mitigate the effects of high winds. An air inlet, necessary for the supply of the burner, is provided in the lower part of the lamp, and it is so arranged that gusts of wind have no effect whatever upon the flame, which burns with almost perfect steadiness.

The usual process adopted for lighting the burner—viz., leaving a small gas-jet burning all day—was found to possess certain inconveniences, inasmuch as its extinction might be caused by a lowering of the pressure in the principal supply-pipe, by a current of air entering the lamp through a broken glass, by an obstruction in the gas-jet itself, or by the entrance of air into the service-pipe in the event of any repairs being made during the daytime. I therefore preferred making use simply of a lighting tube. In the base of the lamp-standard there is a door giving access to two taps—one placed upon the pipe supplying the burner; the other upon a pipe of small diameter, the end of which is close to the large burner, and having in it a number of small holes pierced at regular distances. The moment the tap is opened, and the first jet of the lighting tube ignited, the flame is immediately communicated to the lamp, and as soon as it appears there, nothing remains to be done but to open the main tap, and the lighting of the burner is effected. This once accomplished, the lighting tube may be thrown out of action.

All the photometric experiments were made with the Deleuil apparatus, and in the presence of M. Delanne. The apartment in which they were conducted was divided by a partition, in order that the luminous rays of the photometer lamp and the large burner should not clash. The Carcel lamp—one of M. Giraud's—was also used in testing. A small line of rails facilitated the arrangement of the distance at which the burners to be tried were to be placed, whether they were burning naked or in a lamp. The lamp was then mounted upon a trolly, arranged for the purpose, and attached to the bottom was a pointer, which indicated, upon a graduated fixed scale, the distance of the lamp from the screen.

Lighting by means of high-power burners commenced on the North Jetty and in the Pilots Creek at Havre on the 20th of March last.

The investigations upon which I have been addressing you naturally induced me to seek for the means of affording suitable illumination in manufactories, workshops, foundries, &c., and thus I was led to produce a burner fitted for use in workshops, and consuming 500, 1000, or 1500 litres (17·6, 35, or 53 cubic feet) of gas per hour. These burners are destined to render great service in certain industrial centres, and their moderate price, combined with the fact that they require no change to be made in existing arrangements, will ensure for them an extensive adoption.

The object of the European Gas Company will be attained if my colleagues are enabled, from the results I have laid before them, to find some means of effectually combating electricity, which is seeking by all possible means to fetter our industry, though up to the present time it has only succeeded in supporting its existence with our aid, and by means of our secondary products, since it has already borrowed from us graphite for the manufacture of its pencils, gas for driving its engines, and coke for making its carbons and producing the heat required for working Clamond's thermo-electric pile. And when to these will be added the utilization of tar on a large scale?

* This burner was employed in the competitive trials of gas and electricity for lighting the port of Havre, to which reference was recently made in the Journal (see Vol. XXXIII., p. 991), and also in the report presented at the meeting of the European Gas Company, reported in the present volume, p. 143.

THE ELECTRIC LIGHT ON THE VICTORIA EMBANKMENT.

Report by Sir J. W. Bazalgette, C.B., and Mr. T. W. Keates.

At the time this report was presented to the Metropolitan Board of Works we could not afford space to give it *in extenso*. It was, however, noticed in the Journal for May 13, p. 712; and we now publish it so that our readers may have the full facts as regards this, the first long-continued experiment in electric lighting in the Metropolis. It is as follows:—

Gentlemen,—We have the honour to present herewith our joint report upon the results of the experiments which have been carried on with the electric light upon the Thames Embankment, under the order of the Board of the 18th of October last.

In entering upon this investigation, there appeared to be three main points which offered themselves for our consideration. The first of these related to the motive power to be employed, its cost, and other circumstances concerned in its application to the production of the electrical light; the second to the electrical machinery proper, to the value of the light as an illuminative agent, and to other conditions growing out of that part of the subject; the third, to the comparative cost of the electric light and gas.

It was to these three points that we had to address our attention, and we purpose taking them into consideration *seriatim* in our present report.

In October of last year the Société Générale d'Electricité made a proposal to the Board to light up the Thames Embankment with 20 lights by the system of electric lighting known as the Jablochkoff system, which had been in use in Paris in the Avenue de l'Opéra and elsewhere for some time before. We were instructed to consider the subject, with the view of reporting to the Board as to the advisability of adopting the proposal of the French Company, and finally it was decided that the experiment should be made in the way proposed—viz., that a pair of Gramme dynamo-electric machines should be set up, with the required steam power to drive them, at some convenient point on or near to the Embankment, and that 20 Jablochkoff lights should be placed upon the Embankment parapet on the present lamp-standards. It so happened that, putting an electric light on every alternate standard from Westminster Bridge to Waterloo Bridge, the space was exactly covered by the 20 lights.

Without entering into any detail as to the reasoning by which we were influenced in reporting to the Board the superior suitableness of the Jablochkoff system of lighting to the experiment on the Embankment, we

may mention two points, which in themselves appeared sufficient to turn the scale in its favour. These were, first, the circumstance that in this system no mechanical contrivance is necessary to maintain the proximity of the carbon rods through which the light is produced. Secondly, that there appeared to be, at least at that time, no other system in which so large a number of lights could practically be produced from one dynamo-electric machine as the number then proposed to be lighted on the Embankment. Of course, there were many other considerations, *pro* and *con.*, but those two were thought to justify a preference for the Jablochkoff system for a practical experiment in street lighting. At all events, the Board took that view, and, as we have already said, determined upon making the trial.

The spot selected for setting up the steam-engine and dynamo-electric machines was a space just westward of the Charing Cross Station of the Metropolitan Railway, and there, early in December, was commenced the fixing of the machinery. Concrete foundations were laid down for the engine and electric machines, and great pains were taken that these should be fixed with such solidity as would ensure the greatest possible steadiness in working. The result of four months continued work has shown that these pains were well bestowed, as there has never been the slightest halt or difficulty in the working of the engine or dynamo-electric machinery from first to last.

Motive Power.

The motive power employed was a nominal 20-horse high-pressure engine manufactured for the experiment, and liberally placed at the disposal of the Board for three months, free from charge, by Messrs. Ransomes, Sims, and Head, of Ipswich. When it is remembered that electric lighting means neither more nor less than the conversion of mechanical force into light and heat, and that the regularity and evenness of the light depends more, perhaps, upon the vigour and uniformity with which that force is supplied than upon any other single circumstance, it will be seen that the basis and foundation of success in an experiment of this kind lies, above everything, in the quality and performance of the steam-engine or other motive power which is made use of. In the present case, the engine which was supplied by Messrs. Ransomes and Co., deserves the most unqualified praise.

It might be mentioned here, as we have to give some description of the power and general performance of the engine, that when the proposal of the French Company to establish the 20 lights on the Embankment was made to the Board, it was a stipulation on their part that an engine of 25-horse power should be provided. When application was made to Messrs. Ransomes and Co. concerning the engine, Mr. Head, of that firm, suggested that a nominal 10 or 12-horse power engine would be sufficient, as that could be worked up to 25-horse power. The French engineers, however, pressed their point, and ultimately it was decided that a 20-horse power engine, nominal, should be supplied. The event has fully justified Mr. Head's view, as the results of the continued working of the engine have shown that 10-horse power nominal would have given abundant power for the driving of the two Gramme machines.

The engine, which was expressly built for the experiment, is a double cylinder engine with a multitubular boiler. The cylinders are 10 inches in diameter, with 13 inches stroke; nominal speed, 142 revolutions per minute; heating surface of fire-box, 55 feet; tube surface, 306 feet; water in boiler at working height, 386 gallons.

The principal feature of the engine is, however, an automatic governor of remarkable sensitiveness. The action of this governor rendered the movement of the engine so uniform that in an experiment of twelve nights the greatest difference in the mean number of revolutions of each night was only 1·12 upon an average of 142·36.

The two Gramme machines were driven through an intermediate shaft.

The engine was set up complete on the 10th of December, and on the 12th the electric machines were also fixed in their places, and the engine and machines were ready for the first trial, which was made by successfully lighting up 20 Jablochkoff candles, in the building which had been erected as an engine and machine house, about seven o'clock in the evening of that day.

On Friday, the 13th of December, the ten electric lamps, westward of Hungerford Railway Bridge and extending to Westminster Bridge, were lighted up publicly; on Monday, the 16th of December, the other ten lights between Hungerford and Waterloo were lighted, and from that time to the present the 20 lights have burned for nearly six hours, night after night, without any interruption of a practical character.

After the engine and electric machines had been brought into practical working, which, indeed, was a matter of little or no difficulty, as the whole went smoothly from the first, and the machinery had been at work from the 13th of December to near the end of January, it was determined to make as accurate an experiment as possible to ascertain the exact cost of working the engine in connection with the dynamo-electric machines.

This experiment was commenced on the evening of the 24th of January, and was continued to the 5th of February inclusive, omitting only Sunday, the 26th, of which records were not kept. Every precaution was taken to render this trial of the engine trustworthy, as in estimating the cost of electric lighting, it is in reality the cost of the motive power which is the capital point for consideration. Mr. Lovick personally superintended these trials, and we believe the results may be entirely relied upon.

It was decided that the engine should be driven for 5·5 hours every night, the whole 20 electric lights being lighted at the time; and this was done for the 12 nights mentioned.

In all cases the 20 lamps were lighted within two minutes of starting the engine, except when the diagrams were taken of the effect of working the electric circuits singly; in that case, as the circuits were lighted up one after the other, the diagrams being taken between each lighting, there was some little delay between the lighting of the first and fourth circuit, but this only amounted to about 12 minutes.

In starting the engine on each evening, the fuel required to raise steam to 50 lbs. pressure was counted as fuel to get up steam. The fuel used after that was counted as fuel used in the run; with regard to the former of these quantities, it may be observed that the amount bore a rather large proportion to the general consumption of fuel, as the run only extended to 5·5 hours; the difference is but trifling, but it would have been an economy in favour of the engine if the runs had been longer, or if the engine had been worked nearer to its actual power.

The following are interesting data in relation to this experiment:—

Temperature of water in the boiler when the fire was lighted	130° to 135° Fahr.
Mean temperature of feed-water when entering the boiler	60° Fahr.
Fuel consumed per indicated horse power, mean of the twelve days	3·86 lbs.
Mean indicated horse power for the twelve days	23·34 ,,
Water used per indicated horse power, mean quantity	3·68 gals.
Water used per hour, mean quantity	85·89 ,,
Fuel per hour, mean of twelve days	90·26 lbs.
Mean speed of engine, twelve days, 142·36 revolutions per minute.	

The performance of the engine, as applied to the Gramme machines, was recorded in the following manner, the power absorbed in driving the parts of the engine itself and the intermediate shafting, by which the gearing with the electric machines is effected, being 5·19 indicated horse power:—

First Record.—Driving the two machines without the electrical current passing	7·21 horse power.
Second Record.—Driving the two machines with the current passing between them	9·17 ,, ,,
Third Record.—Driving the machines and one circuit of 5 lights next Westminster Bridge	13·17 ,, ,,
Fourth Record.—Driving the machines and two circuits of 10 lamps	17·93 ,, ,,
Fifth Record.—Driving the machines and three circuits of 15 lamps	20·75 ,, ,,
Sixth Record.—Driving the machines and four circuits, or the full 20 lamps to Waterloo Bridge	23·53 ,, ,,
Or taking the mean of 12 nights, when the 20 lights were burning	23·34 ,, ,,

If we take the figures when the circuits were connected with the engine, and deduct the constant quantity of 5·19 horse power, as absorbed up to the point where the shafting was being driven, the actual power applied in the production of the light would be, circuit by circuit—

No. of lamps, 5; mean horse power, $\frac{13{\cdot}17 - 5{\cdot}19}{5} = 1{\cdot}59$ h. power per lamp.

,, ,, 10 ,, ,, $\frac{17{\cdot}93 - 5{\cdot}19}{10} = 1{\cdot}27$,, ,,

,, ,, 15 ,, ,, $\frac{20{\cdot}75 - 5{\cdot}19}{15} = 1{\cdot}04$,, ,,

,, ,, 20 ,, ,, $\frac{23{\cdot}53 - 5{\cdot}19}{20} = 0{\cdot}92$,, ,,

It will be observed that the horse power per lamp diminishes, although not quite in an exact ratio as the number of circuits is increased. There is an obvious reason for this, as the above records show that an absorption of nearly 4-horse power takes place between the point where the constant 5·19 is taken and the driving of the connected electrical machines. Of course the relation of this quantity is lowered in proportion to the number of circuits in which the current is passing, and an actual diminution of the power applied to do the work at a particular point takes place.

The mean relative cost of working the engine in the twelve days experiment spoken of above, when producing the twenty electric lights during the whole course of the trial, was as follows, per night of 5·5 hours:—

498·5 lbs. Welsh coal	17s. per ton	3s.	9½d.
98·0 ,, ,, to get up steam	,, ,,		9
Wood used to light furnace	say,		3
Oil, per day		1	7
Two men to drive engine and to attend to the electric machines, Jablochkoff candles, &c.	6s. 8d.,	13	4
Two men assisting	5s.,	10	0
Total amount per night		£1	9 8¼

This for 5·5 hours comes to 17·8d. per electric light per night, or at the rate of 3·24d. per lamp per hour. We have included in this the wages of men employed in connection with the electric apparatus as well as with the steam-engine proper, but that will not affect the general result when we come to apply these figures further on.

The capital cost of establishing the machinery on the Embankment may be taken as follows:—

20-horse engine, complete	£495
Two Gramme machines, exciter and distributor, to produce 20 lights	360
Driving-bands for the engine and electric machines	35
3900 mètres of conducting cable, at 2s.	390
	£1280

Leaving the cost of fitting, preparing foundations, &c., out of the question. It is true, however, that the power of the engine is greatly in excess of that required to drive the one pair of Gramme machines. Mr. Head states that the cost of a nominal 10-horse power engine, which would be amply sufficient for that purpose, would be £225

The Gramme machines would be, as before	360
The driving-band would be reduced to	15
3900 mètres of conducting cable, as before	390
	£990

This appears to be a fair sum upon which to calculate the amount of interest and wear and tear to be considered in reference to the whole cost of the electric lights as produced on the Embankment.

Dynamo-Electric Machines.

The more immediate means of producing the electric currents which are made use of for the Embankment lighting, consist in a pair of Gramme dynamo-electric machines, which are called respectively the "exciter" and the "distributor." In the first of these the electric current is generated as a continuous or direct current; this is passed to the second machine, where it is converted into an alternating current, and distributed in four distinct courses or circuits.

These two machines were, with the lamps, candle-holders, &c., placed at the disposal of the Board by the French Society, free of charge; but the cost of fitting the machines, supplying conducting wires, and arranging the lamps was borne by the Board.

We are not prepared to enter into any discussion as to the comparative merits or advantages of the different kinds of machines now in use for producing the electric light. Our experience has been gained exclusively with the Gramme machine, and it is only with reference to the effects of that machine, used with the Jablochkoff candle, that we can afford any reliable information to the Board. Some details must, however, necessarily be given in relation to the exact arrangement by which the currents are taken away and applied to the different points where the lights are produced, as without such explanation the subject would be imperfectly elucidated.

The current of electricity as broken up by the distributor proceeds, as we have mentioned, in four different channels or circuits by means of a conducting cable, which is formed of seven copper wires twisted together in the form of a small rope, and carefully insulated by a thickish coating of gutta-percha and india-rubber. There are four pairs of these conductors attached to the distributor, one of the wires of each serving to convey the current of electricity from the machine, the other to return it to the machine when the circuit is closed. It must not be forgotten that the electric current produced by this machine is alternating—that for one in-

finitely small portion of a second the current passes in one direction; that in the next corresponding fraction of a second its direction is reversed, and it passes in an exactly opposite sense. This reversal of the current is an essential matter in relation to the Jablochkoff system of lighting.

The Jablochkoff candle, as it is called, differs from the other arrangements of the carbon rods, by means of which the electric arc is produced, in one very important particular. Instead of being arranged vertically, point to point, as is the case where any form of regulator is used, the electric arc being formed between the points, the carbon rods in the Jablochkoff candle are arranged side by side, with a space between them of about one-tenth of an inch, which is filled by a sort of septum of plaster of Paris. The electric current passes up one of the rods and down the other, producing the arc as it passes across from carbon point to carbon point. When the electrical current which produces the arc is direct, or passing altogether in one direction, the carbons are consumed irregularly, partly by combustion of the carbon, partly by the transmission of particles of carbon from one carbon point to the other. If this were to happen with the Jablochkoff candle, it would be impossible to obtain uniformity of light; after a while, indeed, the light would become extinguished. This is avoided by using the alternating current, which, as it changes its direction every moment, causes an equal consumption of the carbons, which burn down regularly at the rate of five or six inches per hour. The Jablochkoff candle is supposed to burn for an hour and a half, but it does not really last quite so long.

The conductors, as they are led away from the machine on the Embankment, are carried across the road underground, in a stoneware pipe; they are then conveyed into the subway which extends along under the footway, and the different circuits are taken off as follows:—

1. Westminster Bridge, extending 5 lamps eastward; total length of conducting wire . . . . . 4099 feet.
2. Charing Cross, west, 5 lamps; total length of wire . 2725 „
3. Charing Cross, east, 5 lamps east of Hungerford; total length of wire . . . . . 2464 „
4. Waterloo, 5 lamps next Waterloo Bridge, westward; total length of wire . . . . . 2969 „

At five points in each circuit the double wire is carried up the lamp-post to the top, where a particular kind of table is fixed which is contrived to carry four Jablochkoff candles, and connected with which there is a simple contrivance, so that either of these candles can be brought into the electrical circuit at any moment. The candle which for the time being is lighted, is part of the circuit, the current being brought up by the conducting wire, and connected with one carbon rod, through which the current passes, and after springing across, so to speak, the space between the carbons, is conveyed back by the other carbon to the second conducting wire, and then goes to the next lamp and so on, producing the five lights in each circuit.

It will be observed that a serious defect of the Jablochkoff system of lighting arises out of the arrangements just described. As all the five lights in each circuit are actually forming part of the circuit itself, it follows that any interruption of the current in relation to one light causes the immediate extinction of all five lights, and this was the more serious, inasmuch as, being extinguished, the lights could not be renewed without, as it were, beginning *de novo*, and starting the lights on the particular circuit afresh.

This difficulty has been, however, in great measure, if not entirely overcome. By introducing some conducing material into the earthy matter which separates the carbons, it has been found that the light can be renewed after it has been extinguished, by merely restoring the current. There was another troublesome circumstance, however, connected with this part of the subject. It was that, in changing the candles as they were burned out it was necessary for a workman to go to every lamp and switch, as it is called, the current from the exhausted candle to a new one. This difficulty seems to be also got over. In the arrangements now being made for lighting the remainder of the Embankment with 20 additional lights, the switching of the current from one candle to another is to be done for all 20 lamps from one point.

After passing the fifth light in each circuit, the current is led back to the machine, whence it starts again, but in the opposite direction to that which it followed before, and so on without intermission so long as the machines continue at work.

In consequence of the dazzling nature of the electric light, and its tendency to injure the sight of persons exposed to its influence, it is necessary that the naked light should be screened. Opalescent glass globes have been used by the French Society, both in Paris and in London, and these have been in use on the Embankment, with the exception of one lamp, from first to last. The effect of this opalescent glass is to soften and diminish the light, so that it is possible to look fixedly at the globe without any distress, but at the same time the available light is lowered to a very great extent. A different kind of globe, having a sort of frosted surface, has been used for some time on the lamp under the Hungerford Railway Bridge; this glass stops much less of the light than the opalescent glass. The proportions of loss in both cases we shall give hereafter.

We now come to a question of very great importance in relation to the matter of electric lighting—What is the value of the light?

The accurate estimation of the amount of light given off from the electric arc and the ignited carbons is a matter of very great difficulty, so much so that the best results which have been obtained can only be looked upon as fairly approximating to the truth. This arises, according to our experience, from two causes—first, from the difference between the colour of the electric light and that of any standard of light which we have at our disposal; secondly, from the fluctuating character of the electric light, which prevents the experimenter from ever obtaining, even for one moment, a steady indication upon the screen of the photometer.

A number of experiments was made at the machine-house on the Embankment, where a complete photometer was fitted up. These experiments were—

1. Upon the naked light.
2. Upon a light with an opalescent globe.
3. Upon a light with a frosted globe.

The measurements were made horizontally in each case.

The instrument employed was a bar photometer, fitted in the usual way, and the observations were taken upon a movable screen with a star disc. In our first trials we made some comparative experiments with shadows and with illuminated surfaces, but these were not satisfactory, and we were obliged to revert to the use of the ordinary arrangement with the moveable screen, which, after some little trouble, and our becoming perhaps more practised at the work, answered very well, and we were able to get fairly satisfactory results; but, as we have already said, such results, however carefully they may be obtained, are not exact, although they no doubt approach the truth nearly enough for practical purposes.

The standard unit of light which was used was a sperm oil-lamp, very carefully constructed by Mr. Sugg, and fitted to the photometer by a peculiar balance, by which the necessity for removing the lamp during the course of any number of experiments is obviated, and the experiments may be made to follow each other with very little delay. This lamp, consuming sperm oil at the rate of 925 grains per hour, and having a flame as nearly as possible 2 inches high, gives light equal to that from 16 standard sperm candles, such as are used in the parliamentary standard of gas in the Metropolis. The lamp is, indeed, exactly equal to that standard.

In every experiment the electric light was placed 240 inches from the measuring light, the screen moving between them.

Twenty readings or observations were made in each experiment, both with the open and shaded lights. Eight experiments were made on as many different nights between the 27th of February and the middle of March, with the naked light. Three experiments were likewise made with the light surrounded with the opal globe, and two with the light in the frosted globe. The following are the results obtained in these experiments:—

Naked light, mean of eight experiments . . .		378·1	sperm candles.
Opal globe „	three „ . . .	154·9	„
Frosted ditto „	two „ . . .	265·0	„

The loss of light produced by the opal glass was therefore equal to 59 per cent.; by the frosted glass only 29·9 per cent.

We consider that these figures fairly represent the full value of the light under the above conditions. It is, however, so difficult to lay down any exact principle in reading the indications on the photometer, that some difference must be found in the results obtained by different observers, although we believe that in careful and experienced hands the differences will not amount to anything of much practical importance.

Taking the above figures, it will be observed that the gross output of light from the 20 Jablochkoff candles amounts to 7562 candles. Nearly 60 per cent. of this is, however, absorbed at once by the opal globes, and, in fact, this is not the only loss. There are two other sources of practical loss, where the chief effect of the light is required to be in a direction downward from the lamp. This loss arises, in the first place, from the greater thickness of the opal glass in the lower third of the globe; and, secondly, from the fact that the most favourable direction for the projection of the light from the Jablochkoff candle is rather upwards, and there is an actual diminution of light horizontally, and more in a downward direction. The consequence of this is that the actual loss of light is, no doubt, much more than 60 per cent., but what the actual loss is we are not prepared to say.

It may be mentioned here that the mean speed of the dynamo-electric machines was—for the exciter, 624; for the distributor, 651 revolutions per minute.

This speed varied but very little from time to time, owing to the great evenness of the working of the steam-engine, a circumstance to which we have already directed attention.

On the 14th and 15th of March a very important and interesting experiment was made, with the object of ascertaining whether or no the circuits could be increased in length to any considerable degree without diminishing the apparent value of the lights on such circuits. In order to test this, the two extreme circuits—that is, the Westminster circuit and the Waterloo Bridge circuit, containing 4099 and 2964 feet of wire respectively—were thrown into one, making the total length of wire 7063 feet. On this the five lights were lighted as usual, excepting that three of the lights were those at the extreme Westminster end, and two at the extreme Waterloo end. The lights lighted up and burned with the ordinary regularity; it was, indeed, quite impossible to distinguish between them and those burning on the other two circuits, which, it ought to be mentioned, were going on as usual. On the next evening after this experiment, a further length of 1752 feet of wire was added to the same circuit, making a total length of wire of 8815 feet, or 1·66 miles. The lights were lighted as before, and still the addition of the further length of wire seemed to produce no diminution in their brilliancy. We believe that this is by far the longest circuit that has been practically attempted, particularly with a machine giving an alternating current; and it seems to us that the importance of the result is very great in relation to the general question of electric lighting. With reference to this experiment, it should be stated that the wire which was used was of the same size all through the length of the increased distance, and was similar in all respects to that used in the other circuits.

Referring back to the figures already given as to the capital required to set up the plant of steam-engine, electric machines, &c., and the current cost of working the same, and having also given the value of the light itself as reduced to a well-known standard, we now come to consider the question of the cost of maintaining the light. In order to render that as clear as possible, we have brought out the results at so much per electric lamp per hour. This is not only more convenient, but it is the plan which has been adopted by others who have investigated the subject, and therefore it affords the best mode of comparison with the work which has been done previously at home and abroad.

Looking back it will be seen that the capital required to establish a plant for producing 20 Jablochkoff lights is £990.

The interest at 5 per cent. per annum on that sum is . .	£49	10
Wear and tear, 10 per cent.	99	0
Total	£148	10

The whole time during which the gas lamps are lighted in the streets appears to be about 4300 hours in the complete course of the year; in electric lighting the time used up in lighting and extinguishing the gas lamps is almost entirely saved, therefore we may assume that the actual time during which the lights would be burning would be about ten hours per day on the average, or, say, 3600 hours in the year. The £148 10s. per annum interest on capital, and wear and tear of machinery, when divided over 3600 hours, comes to 9·9d. per hour; which, on 20 lights, gives 0·49d. per hour per light.

We have already shown that the cost of working the steam-engine, &c., per night of 5·5 hours amounted to 17·8d. per light, or 3·24d. per light per hour; add to this the 0·49d. per hour per light for interest on capital, &c., and we have 3·73d. as the cost of producing each electric light per hour, less the cost of the Jablochkoff candle.

With regard to this last point, there is some difficulty. When the experiment was commenced, the price charged to the Board by the French Society for the carbon candles was 6d. per lamp per hour. Since the 1st of February that has been reduced to 5d.; but now, under the new arrangement, by which the additional lights are being put on the Embankment, the French Society undertake to maintain the lamps all round at the rate of 5d. per hour per light, net; that is inclusive of the cost of working steam-engine, electric machines, and all other current charges. This, according to the figures already given, leaves but a small sum to pay for the candle. It is, however, believed that more work can be obtained from the steam-engine; at present, preparations are being made for putting 40 lights on the engine as it stands, and it is suggested that 20 more may be worked by it. If these ideas prove correct, of course the whole cost of working will be reduced, and the sum which is paid—viz., 5d. per hour, including all charges, may be remunerative. We can, of course, only deal with the figures which we have before us, and which have been obtained with great care and attention; but in the face of the reduced price per electric candle which the Society are now charging, it seems useless to

reckon the cost of the candle at the price which the Board paid—viz., 5d. per hour. Taking all the circumstances into consideration, we believe that 2d. per hour for the candle would be a very sufficient charge. We should then have as the total cost of producing the light per lamp per hour—

Interest on capital; wear and tear	0·49d.
Current charge of working engine, &c.	3·24
Cost of Jablochkoff candle	2·00
Total	5·73d.

Electric Light compared with Gas.

Having brought the subject to this point, it is easy to make a reasonable comparison between the cost of lighting by the electric light and by gas under conditions similar to those of the experiment on the Embankment. When it comes to the application of the electric light to lighting the interior of buildings, no doubt fresh conditions would arise, and they would have to be taken into proper consideration.

So far as our investigation is concerned, the comparison is not difficult. In the first place, however, it will be necessary to learn what the electric lights have done in substituting gas on the Embankment. The number of gas lamps between Waterloo and Westminster Bridges is 86, but as the parapet lamps have two burners each, the 86 lamps are equivalent to 119 burners. Of these, 20 lamps near Westminster are supposed to consume each 3 feet of cannel gas per hour; 33 lamps on footways along the other part of the Embankment, 5 feet per hour; and 33 lamps, equal to 66 burners, on the parapet, 4 feet per hour.

We have ascertained the actual lighting power of these burners, taking for experiment burners indiscriminately from the lamps in the different places mentioned. They give of light—the 3-foot cannel burners, nearly 14 candles; the 5-foot burners on the footways, about 14 candles; the 4-foot burners on the parapet, nearly 9 candles.

This is estimating the burners at their full value, and these figures give as the total lighting power of the gas usually burning on the Embankment 1336 candles. Practical experience has shown that all these could be replaced by the electric lights on the parapet, as during nearly the whole of the duration of the experiment the gas lamps on the parapet and footway next the parapet have been left unlighted every evening, and for some time the lamps on the opposite side—that is, on the further footway between Northumberland Avenue and St. Stephen's Club—were not lighted; so that there has been abundant opportunity of knowing that the whole of the gas mentioned above might be superseded. If we refer again, however, to the statement of the lighting power of the electric light, taking first the light as given through the opal globes, and, secondly, that as given through the frosted globes, we shall find that the gross light from the 20 electric lamps with the opal globes amounts to 3098 candles, or 2·3 times as much as that given by the gas, while with the frosted globes the gross light amounts to 5300 candles, or about four times the light given by the gas. It may further be remarked here that the position of the electric lamp is unfavourable to the production of the best effect in lighting; for not only is one-half the light—that is, the light which is thrown towards the river—virtually lost, but in another respect it is most seriously sacrificed.

The general width of the Embankment is about 100 feet. If we assume, for the sake of argument, that the electric lamps on the parapet can throw a light into the centre of the roadway, 50 feet distant, equal to 100 candles, that light would be diminished to 25 candles at the farther side of the road; if, on the contrary, the electric lamp itself were in the centre of the road the light on each footway would be equal to 100 candles. This shows that a large amount of available light is lost by placing the lamp at the side of the road, as in the present arrangements.

As it is, however, the light on the Embankment is greatly in excess of that which is given by the gas, but what the advantage is it is, of course, not possible to say with exactness.

Mr. Sugg's experiments with large-sized gas-burners afford the best means of comparison as to the cost of the electric light and gas; but, as will be seen, the results of this comparison must depend upon the conditions under which the electric light is used. These conditions in the Embankment experiment were three—naked light, light in opal globe, and light in frosted globe—but the first of these may be neglected, as, practically, it does not appear that the naked light can be employed.

The light in the opal globe was equal to, say, 155 candles, that in the frosted globe to 265 candles. To produce a light of 155 candles in one of the large Sugg burners, about 48 cubic feet of gas per hour must be consumed. To produce a light equal to 265 candles it would require about 83 cubic feet of gas per hour. This is calculating the value of the gas at 16 candles per 5 cubic feet, and making no allowance for the advantages which Mr. Sugg shows to accrue from burning the gas in large quantities together.

The cost of 48 cubic feet of gas may be taken at 2d., that of 83 feet at nearly 3·5d. It has been already shown that the cost of producing the electric lights each amounts to 5·73d. We find, then, by the above figures, that gas, to produce light equivalent to that of the electric light with the opal globe, costs 2d. per hour, while to produce light equal to the electric light in the frosted globe the gas costs 3·5d. per hour, or, arranging these figures in a plainer way—

Cost of electric light	5·73d. per hour.
Gas equivalent to electric light in opal globe . .	2·00 "
Do. do. frosted globe .	5·50 "

As to the character of the electric light *per se*, we have very little to say. This is so much a matter of personal opinion that every one who has seen the light can form his own judgment on this point. The lights on the Embankment have burned, on the whole, very steadily and well, and we have never seen any wavering or fluctuation in the light which could interfere with its practical working. We have not observed in it any of the ghastliness of effect which has been complained of, and when the 20 naked lights were, on an early occasion, lighted up at one time in the machine-house, the impression on those present was that the character of the light was that of bright sunshine.

There can be no doubt that electric lighting has now established itself as a light which, under particular circumstances of street lighting, or lighting of great interiors, railway stations, or similar places, will be used but at present there are defects connected with it that must prevent its; adoption as a general mode of lighting competing with gas. There is, in our opinion, no prospect at present of any such general competition.

It now only remains for us to represent to the Board the very important assistance which has been given to us during the investigation, of which this report is the outcome, by the following gentlemen—Mr. Lovick, the Assistant Engineer to the Board, without whose assiduous care and watchfulness many of the data contained in the report could not have been given; Mr. Head, of the firm of Ransomes, Sims, and Head, who has all through been ready to give us every information and assistance with the greatest courtesy, and who furnished valuable data connected with the working of the engines; M. Jules Berly, the Engineer to the French Society, who has had the fitting up of all the electric machinery on their part, and who has also been on all occasions ready to assist us in arranging our experiments, and in any other way in his power; and M. Jules Gaudet, the Engineer to the French Society, who likewise was on all occasions anxious to assist us in every way.

(Signed) J. W. Bazalgette, Engineer.
T. W. Keates, Consulting Chemist.

EXTENDED USE OF WATER GAS IN AMERICA.

We understand that in the last week in June, Mr. T. F. Rowland, whose water gas process was described and illustrated in the Journal for July 16 last year (Vol. XXXII., pp. 87 *et seq.*), received instructions to alter the works of the New York Gaslight Company—the oldest but one of any incorporated gas company in the States—so as to manufacture gas according to his patented method.

In connection with this we may state that all the Gas Companies supplying New York City have announced a reduction in price, to take effect from the 1st inst. The reduced rates range from 2 dols. to 1 dol. 25 cents per 1000 feet; and from the *New York Herald* of Thursday, the 10th inst., it would appear, that this action on the part of the Companies has been made the occasion for a *Herald* reporter interviewing the various officials connected with the Companies. We reproduce the following extract, which shows what he has to say about his interview with the Secretary of the Municipal Gaslight Company, who are at present supplying water gas, made by the same process that the New York Gaslight Company are now going to adopt:—

In the new building on the south-west corner of Twenty-sixth Street and Fourth Avenue are the offices of the Municipal Gaslight Company, and there the *Herald* reporter found Mr. Philip Allen, its Secretary, who was quite willing to impart any information in his possession on the subject of the former's visit.

"This Company," said Mr. Allen, "employs a process in manufacturing its gas invented by a Frenchman named Tessié du Motay. It is popularly called 'water gas.' We use coal to decompose the steam, and then it is carburetted with naphtha to produce gas."

"How many consumers do you supply?"

"We have at the present time between 6000 and 7000. The Company was organized in 1874, but real work was not begun until 1876."

"Have you followed the example of the Manhattan Company in reducing the price?"

"We have," was the reply. "Here it is, as it went into effect on the 1st of July," he added, at the same time handing the reporter a slip of paper on which the following schedule was printed:—Under 10,000 cubic feet, 2 dols.; 10,000 to 15,000, 5 per cent. discount; 15,000 to 25,000, 10 per cent. discount; 25,000 to 35,000, 15 per cent. discount; 35,000 to 45,000, 20 per cent. discount; above 45,000, 25 per cent. discount.

"What rate were you charging before the reduction?"

"We charged 2·40 dols. per 1000 cubic feet."

"Do you charge deposits on your meters?"

"No; we ask no deposit from any responsible party. There being no deposit required, gas at the reduced cost will be within reach of poor people who hitherto probably thought themselves unable to afford the expense."

"What is the character of the gas made by your process?"

"There it is," he replied, pointing to a clear white light burning from a side bracket; "it is of 22-candle illuminating power. How this compares with the gas manufactured by the other Companies is shown by the examinations made at the photometrical rooms of the Department of Public Works of the gas consumed by the city for the three weeks ending on the 28th of June last. The record shows that while the Municipal Company was making gas, as is proven by its books, of 22-candle illuminating power, the average power of the New York Company's gas was 16·89; that of the Manhattan, 17·15; the Mutual's was 18·08; the Metropolitan's, 18·29; and the Harlem's, 16·50."

This additional value of the water gas is strikingly shown by a comparative statement which has been published, based on actual figures from bills furnished by the Proprietor of the Westminster Hotel, New York, who in the sixteen weeks ending July 10, 1876, at 2·50 dols. per 1000 cubic feet, burnt 1445·50 dols. worth of ordinary gas, and for the corresponding period of 1877, with water gas at the same price, his bill only amounted to 985·75 dols., showing a difference in favour of the latter of 459·75 dols., or 31·8 per cent.

THE LANCASHIRE COAL AND IRON TRADES.

(FROM OUR OWN CORRESPONDENT.)

Short time is now almost general throughout the Lancashire coal-field, and there are very few of the pits that are running more than seven or eight days a fortnight, and the probability is that the output will have to be still further reduced, as there is a continued falling off in the demand for all classes of fuel. The better classes of round coal for house-fire purposes are now meeting with an extremely dull sale, and there is but a very small inquiry for gas-making coals. Common round coals and engine fuel are generally a drug in the market, and slack is unusually plentiful for the season of the year, the lessened production of this class of fuel being quite counterbalanced by the restricted requirements for mill use and brick-making. Prices generally are very weak, and there are rumours that some reductions will be made in the Manchester market at the end of the month; but although there is a giving way on the part of sellers where fresh orders have to be sought, which in the end means a gradual lowering of values generally, prices are now too low to admit of any sweeping reductions, and if any alteration is made in quotations, it will not be to any material extent, and in all probability will have already been discounted by previous reductions. The better qualities of round coal for house-fire purposes can be bought readily at from 8s. to 8s. 6d. per ton, and good second qualities at from 6s. to 6s. 6d. per ton at the pit. For gas-making coals prices still rule extremely low, and where contracts are being secured, 6s. 6d. to 7s. per ton for good screened Arley at the pit mouth are about the outside prices which are being obtained. Common round coals are very low in price, and for large orders 4s. 6d. per ton at the pit has been taken, but the average quotations are about 4s. 9d. to 5s. 3d. per ton. Burgy ranges from 3s. 9d. to 4s. 6d., and good slack from 2s. 9d. to 3s. 6d. per ton at the pit.

The iron trade is extremely dull, and in no branch is there any sign of improvement. The chief portion of the Lancashire furnaces are out of blast. Forges in most cases are not running more than three to four days a week, and engineers and machinists are all very short of orders. Lancashire foundry pig iron delivered into Manchester could now be bought at under 44s. per ton, less 2½, and common bars at about £5 per ton.

THE COAL AND GENERAL TRADES OF THE NORTH OF ENGLAND.

(FROM OUR OWN CORRESPONDENT.)

The gas coal trade of the county of Durham is a little dull, rather more so than is usual at the time of the year, which is usually a slack period in the trade. Prices do not exceed 6s. a ton, as a rule; however, when sales

are entered upon in the open market, in some instances a little more discount has to be allowed to make business. There is a scarcity of trade for second-class pits, with little prospect of immediate improvement. The price of second-class gas coals is low; inferior sorts are difficult to place in the market at any price. This condition of affairs is likely to continue. Gas companies, in the present state of the market, prefer the better qualities of coals. Inferior do very badly for local use. Steam coals, especially the better sorts, do remarkably well as regards shipments, but they are low in price. Coke is in moderate demand.

The market for coasting shipping continues to favour the exporter. Coasting rates keep low; 4s. 10½d. is paid small vessels to discharge gas coals at the wharves below London Bridge. Some little business is also being done in gas coals to the Channel ports, to Holland, and to Ireland, at equally low freights. There is no great reason to believe that they will alter very much during the season. Though the small sailing ships are not very numerous, there are more than there is business for them to do. The coal trade has been entirely changed as regards small sailing vessels. Within a very few years it would seem as if they would altogether disappear. They are a class of property which by no possibility are able to make a profit for their owners, and as ships are lost they will not be replaced. There is no probability of that. The sea-borne gas coal trade of the future will no doubt be done by steamers built for the purpose, vessels which will be able to go wherever small sailing ships now trade. There will be a considerable advantage in this, as the smaller gas-works will be able to calculate upon a uniform delivery of coals over the year, and need not be so much troubled with stocks as they are at present.

General manufacturing trade is unchanged. The iron business of the Cleveland district is no worse. Possibly there is a slight improvement, but it is hardly perceptible. The chemical market is steadier, with an advance of something like one per cent. upon most articles. There were large deliveries of Spanish lead upon the Tyne last week. Lead is low in price, and somewhat hard to sell. There is a slight improvement in the timber trade. There is no alteration in the fire-brick or fire-clay goods trade.

TRADE NOTES FROM SCOTLAND.

(FROM OUR OWN CORRESPONDENT.)

At the monthly meeting of the Forfar Gas Commission, held last Monday evening—Provost Lowson presiding—the accounts for the year ending the 15th of June were brought under consideration by Bailie Laird. He noticed, as a gratifying fact, that the net profit resulting from the last year's working was £1006 14s. 8d., which it would be necessary to dispose of at the annual meeting in August. In the meantime it seemed probable that a reduction of 5d. per 1000 cubic feet would be made on the price of gas to the consumers. At this time last year a similar reduction was made, and with the contemplated reduction, together with the discount allowed to those consumers who might pay within a month, would make the price 4s. 9d. It was also satisfactory to find that the estimates had, as a whole, been realized. The Bailie bore testimony to the capital management and anxious desire of the Manager (Mr. Esplin) to do everything in his power for the benefit of the Corporation, and to be as economical as possible. Referring to the leakage, he said it had fallen gradually for years from 13·39 to 7·85 per cent., which he believed was as low as, if not the lowest of any gas-works in Scotland. Under their Gas Act they were bound to supply a gas of the illuminating power of 18 candles, and the photometer had shown the average power to be from 29 to 30 candles. With the view of being able to purify the gas more thoroughly, and increase the value of the residual products, it was subsequently resolved to order a new scrubber at a cost of £205; and on the recommendation of the Committee it was agreed to add £15 to the Manager's salary, and to grant him a bonus of £10 for the past year.

The annual meeting of the Lockerbie Gas Company was held last Monday—Dr. Wilson, Chairman of the Directors, presiding. The past year's accounts were submitted and approved of, and the annual dividend was declared at the rate of 7 per cent., as against 10 per cent. for the preceding year.

The report of the Directors of the Lanark Gas Consumers Company, Limited, has just been issued to the Shareholders. It shows a large profit for the past year, and, after providing for the payment of a dividend of 5 per cent., as recommended by the Directors, there is a sum of £541 18s. 9d. left to be carried forward for extraordinary repairs and alterations. The Directors recommend that, from May 31 last, the price of gas should be lowered 10d. per 1000 cubic feet—that is to say, from 5s. to 4s. 2d. They have this year contracted for their coals at a comparatively low price, and they think it fair that the consumers should get the benefit of the fall. Since the year 1874 the price of gas has been reduced from 8s. 4d. per 1000 feet, and a debt of £800 has been paid off, in addition to which there has been spent on improvements a large sum that has been taken out of profits. Previous to the year 1873 it was a rare thing for any dividend to be paid to the Shareholders. In that year it was 2½ per cent., and for some time it has been 5 per cent. Since the termination of the ruinous competition that existed for so many years between the two Companies, Lanark is now gradually taking its proper place amongst the towns where cheap gas is produced.

In connection with the discussion which was provoked some weeks ago on the question of manufacturing the cheapest gas in Scotland, attention has just been drawn to the fact that Perth has a better right than Dundee to claim that honour. In the case of both of these towns there were originally two Gas Companies to buy up, and, considering the annuities fixed by Parliament to be paid to the Shareholders of the Companies in the two towns, it is observed that for the year ending April 30, 1879, every 1000 feet of gas sold in Perth required to be burdened with 1s. 2d. to meet the annuities, while in Dundee the amount required for the same purpose was only 8d. per 1000 feet. There is thus a difference between Perth and Dundee of 6d. per 1000 cubic feet in the actual cost of production. For the year ending April 30, 1879, the price of gas in Dundee was 3s. 11d. per 1000 feet, while in Perth the price was 4s. 2d.; so that on that basis of consideration gas was actually manufactured in Perth at 3s. 8d., or 3d. per 1000 feet lower than in Dundee. It is further argued that there would be found to be a greater disparity in the price of gas in the two towns if the Dundee Gas Commissioners, instead of adopting the practice of adding to capital large sums of money for repairs, &c., were to pay them out of revenue, as is the case in Perth. The total difference in favour of Perth would be, it is alleged, 5d. per 1000 feet; in other words, while the selling price was 4s. 2d. in Perth, it would have been 4s. 7d. in Dundee, on the same principle of calculation, and considering the annuities.

The Dundee Water Commissioners have raised the domestic water-rate from 1s. 1d. to 1s. 4d. per pound of rental, and, in addition, the Police Commissioners have agreed to pay the sum of £1000 instead of £600, as hitherto, on account of water used for public purposes.

On Tuesday last the connection was effected between the Dundee water system and the village of Newport, on the south side of the Tay, *viâ* the Tay Bridge. The reservoir at Wormit, at the south end of the bridge, will not be completed for some time. It is certainly a novelty in modern systems of water supply to see water sent across a river two miles in width.

A meeting of the Edinburgh and District Water Trust was held on Friday—the Lord Provost presiding. On the recommendation of the Works Committee, it was resolved to give a supply of water to the town of Dalkeith at the rate of 3d. per 1000 gallons. The annual accounts of the Trust from May 15, 1878, to May 15, 1879, were approved of and certified in terms of the statute. The revenue account showed a total for the year of £62,988, including £3750 of a balance to begin with, and £842 of arrears of water-rates. £22,430 was paid in interest, and £24,323 in annuities. The property account shows a balance of £1,035,035 at the 15th of May last, as compared with £926,394 at the corresponding date last year. There had been expended during the year—Gladhouse reservoir, £16,844; Edgelaw reservoir, £18,673; Fountain Hall reservoir, £18,975; Portmore reservoir, £9649; Rosebery reservoir, £103; and additional supply distribution-pipes, £16,936.

The annual meeting of the Kilmarnock Water Company was held on Friday week, when it was agreed to declare a dividend of 6½ per cent. on the ordinary and 4 per cent. preference stock, and of 6 per cent. on the 4½ per cent. preference stock. The revenue amounted to £3185 12s. 7d., and the balance of profit was £2117 19s. 5d. There was added to the reserve-fund the sum of £620.

A decided change for the better was observable in the Glasgow pig iron market last week. There was a strong market, with a large business done at advanced prices.

No improvement can be reported regarding the coal market.

SALE OF IPSWICH GAS COMPANY'S SHARES.—On Tuesday last Messrs. Garrod, Turner, and Son offered for sale, at the White Horse Hotel, Ipswich, 18 original £10 shares, 12 B shares (second issue), 10 C shares (third issue), and 45 new £10 C shares in the Ipswich Gas Company. The original shares realized on the average £19 5s. each, the B shares £14 6s., and the C shares £14. The new C shares were sold—35 at £13 17s. 6d. and 10 at £14.

DEATH OF MR. G. W. DRORY.—The death is announced, at Meirelbeke, Ghent, of Mr. George William Drory, who was connected with the Imperial Continental Gas Association for upwards of 54 years, during the greater part of which time he was the General Superintendent of the affairs of the Association on the Continent. He retired from the more active discharge of his duties about twelve months ago, but continued to be Consulting Manager of the Association up to the time of his death, on the 19th inst., in the 77th year of his age.

REDUCTION IN THE PRICE OF GAS AT PETERBOROUGH.—At a meeting of the Directors of the Peterborough Gas Company, last Tuesday, it was resolved to make a reduction in the price of gas, as from Midsummer, of 3d. per 1000 feet to private consumers, and 2d. per 1000 feet to the Railway Companies and to the Corporation for public lighting. This brings the price down to 3s. 10d. for the railways and public lamps, and 4s. 3d. for private purposes, the proportions of consumption being 2-5ths and 3-5ths respectively. Considering that the maximum dividends of the Company amount to just 2s. per 1000 feet of gas sold, the prices now charged are most reasonable, and show that, under the care of the Engineer and Manager (Mr. G. Ernest Stevenson), the manufacturing operations are very economically carried on.

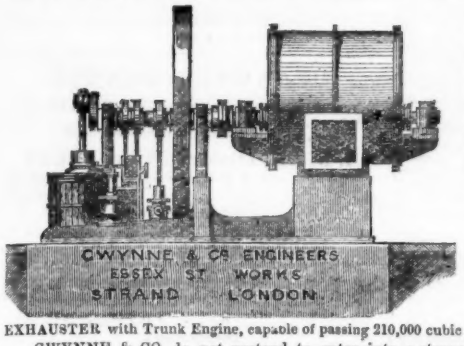
PETERBOROUGH WATER SUPPLY.—On Tuesday, the 15th inst., the Mayor of Peterborough, Mr. John Core, gave a *déjeuner*, in commemoration of the introduction of water into that town, by means of the recently constructed works for its supply to the borough. The water is obtained from a well at Wilsthorpe, near Bourn, Lincolnshire, 16 miles from Peterborough. It is exceedingly pure water, derived from the same source as that which supplies the Spa at Braceborough, and from which the far-famed Bourn water is obtained. For ordinary purposes the water is pumped from a well by means of a pair of 34-inch high-pressure condensing beam engines, and for night service it is pumped into a reservoir of 1 million gallons capacity, constructed upon, or rather in a natural elevation of 135 feet above Peterborough, known as Obthorpe Hill. Provision is also made for a higher pressure by means of a stand-pipe. The works have been constructed at a cost of about £90,000, according to a scheme devised and carried out by Mr. John Addy, civil engineer, of London and Peterborough.

LIGHTING THE CAPITOL AT WASHINGTON (U.S.A.) BY ELECTRICITY.—The arrangements for lighting the Capitol building with a new electric light are, says the *Scientific American*, nearly completed. The experiment has already been made in the hall of the House of Representatives, and a single light placed on the front row of the reporters gallery and over the Speaker's chair made the whole hall so light that print could be easily read at the points farthest from the burner. The plan is to place four lights in the hall, and it is now believed that they will be a very great improvement upon the present arrangement of gas-burners. Three electric machines have been purchased, under the appropriations for lighting the interior of the building, and it is in contemplation to place another in position for the purpose of supplying a light of vast power upon the top of the dome. It is claimed by the inventors that a burner can be constructed there which shall have a very appreciable effect upon a large area of the city. It is claimed that with the steam power of the heating and ventilating apparatus in each wing of the building, a dynamo-electric machine of 175,000-candle power can be run.

WATER AS A MOTIVE POWER.—A novel application of the use of water pressure, promising to be of considerable importance to local authorities in connection with the water supply of their districts, has recently been worked out by Messrs. W. H. Bailey and Co., of the Albion Works, Salford, who have constructed for the Brighton Corporation a water-motor pumping-engine. The machine, which is constructed on the patent of Mr. W. H. Bailey, is somewhat similar to the water-engines recently made by the firm for organ-blowing and lifting and hoisting purposes, and its special object is the forcing of water from a low-pressure reservoir to one far above its level. In order to make the matter clear, it may be explained that the engine will in reality have to do with three reservoirs at Brighton, one to be situated at Park Road; a second at Islingword Road, 82 feet below Park Road; and the third at Warren Farm, 289 feet above the level at Islingword Road. The engine itself will be fixed at the Islingword Road station. The water coming from the Park Road reservoir to the one at Islingword Road, and passing thence to supply the needs of the inhabitants of Brighton below, will actuate the engine, which, being set in motion, will forthwith force a quantity of water to the station at Warren Farm, which is not only, as previously mentioned, 289 feet higher than, but also 2887 yards distant from Islingword Road. The economy of this arrangement will be at once apparent. The only motive power is the water which is afterwards used by persons living on the lower level, and the only charge upon the Corporation will be the interest on the purchase-money. It must not be overlooked that the machine is entirely automatic in its action, and, having no "dead centre," stops and starts automatically without requiring any attendant to be near it. In the event of there being a sufficient quantity of water at the high-level reservoir, the machine will at once stop, and remain motionless until more water is required.

The GRAND MEDAL of MERIT at the VIENNA EXHIBITION, TWO MEDALS at the PHILADELPHIA EXHIBITION and TWO MEDALS at the PARIS EXHIBITION, have been AWARDED to GWYNNE & CO. for GAS-EXHAUSTERS, ENGINES, and PUMPS; Also 27 OTHER MEDALS AWARDED at all the GREAT INTERNATIONAL EXHIBITIONS.

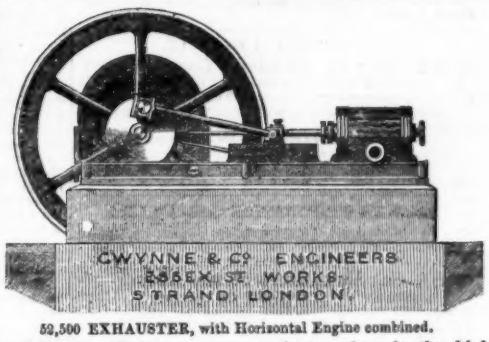
GWYNNE & BEALE'S PATENT GAS-EXHAUSTERS & ENGINES.



EXHAUSTER with Trunk Engine, capable of passing 210,000 cubic feet per hour.

The Judges report on the combined Exhauster and Steam-Engine exhibited at the Philadelphia Exhibition is—"*Reliable compact Machine, well adapted for the purpose intended, of excellent workmanship.*"

GWYNNE & CO. have made the largest and most perfect Gas-Exhausting Machinery in the world, and have completed Exhausters to the extent of 8,000,000 cubic feet passed per hour, of all sizes from 2000 to 210,000 cubic feet per hour.



52,500 EXHAUSTER, with Horizontal Engine combined.

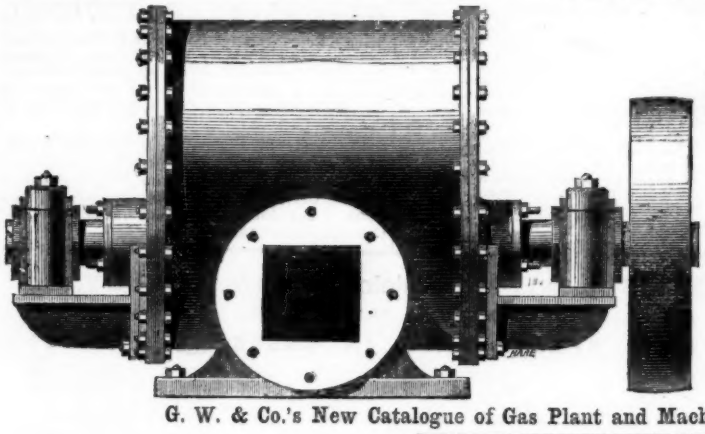
GWYNNE & CO. do not pretend to enter into a struggle with other makers in respect to cheapness. They have never sought to make price the chief consideration, *but to produce machinery of the very highest quality, and most approved design and workmanship.* The result is that in every instance their work is giving the fullest satisfaction. Numerous testimonials and references can be given to Companies using their Machinery for years past.

Exhausters, with or without Engines combined, can be made to pass the gas WITHOUT OSCILLATION OR VARIATION IN PRESSURE Regulators, Bye-Passes, Stop-Valves, Gas-Valves, Station Governors, and Gas Machinery of all Sizes.

PLEASE ADDRESS IN FULL, **GWYNNE & CO., Hydraulic and Gas Engineers, ESSEX STREET WORKS, VICTORIA EMBANKMENT, LONDON, W.C., ENGLAND.**

Gwynne & Co.'s New Catalogue on Gas-Exhausting and other Machinery may be obtained on application at the above Address.

BEALE'S IMPROVED PATENT GAS EXHAUSTERS,



WITH OR WITHOUT

WROUGHT-IRON SPINDLES AND

ENGINES COMBINED.

GEORGE WALLER & CO.,

MAKERS OF

ENGINES, EXHAUSTERS,
INDEX AND DISC GAS-VALVES,
HYDRAULIC MAIN VALVES,
BYE-PASS VALVES,
TAR, LIQUOR, AND OTHER PUMPS,
SCRUBBERS AND PURIFIERS,
CONDENSERS, BOILERS, &c.

G. W. & Co.'s New Catalogue of Gas Plant and Machinery can be had on application.

PHŒNIX ENGINEERING WORKS:

HOLLAND STREET, SOUTHWARK, S.E.

WANTED, Readers of the NEW Edition, 1879, "Cooking & Heating by Gas;" on Burners, &c. Copies, by post, Threepence, direct from the Author, MAGNUS OHREN, A.I.C.E., Gas-Works, SYDENHAM, S.E.

WANTED, Masonic Votes on behalf of a Child of the late Bro. John Johnson, who was a Subscribing Member of the "Evening Star Lodge," No. 1719, and a Member of the British Association of Gas Managers.

Votes received by Bro. MAGNUS OHREN, Lower Sydenham, KENT, Secretary of the Lodge.

WANTED, by Advertiser, aged 21, a Situation in a Gas-Works, as ASSISTANT to the Engineer. Good Draughtsman and Chemist.

Address No. 565, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

WANTED, a Situation as Manager or ASSISTANT MANAGER of a Gas-Works on the Continent or Abroad. Thoroughly efficient in every department. Aged 30. Speaks French and Italian. Good testimonials.

Address GAZ, care of Advertising Offices, 150, Queen Victoria Street, LONDON, E.C.

WANTED immediately, by a Provincial Gas Company in the South of England, a First-class FOREMAN over the Retort-House. Alternate day and night duty. None but persons having experience, steady, and of good character, need apply. Wages £2 weekly.

Address No. 566, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

BOOK-KEEPING.—Lessons wanted in the System of Book-keeping adopted by Gas Companies. Instructor must have practical experience.

Address CARBON, Deacon's Advertising Offices, Leadenhall Street, LONDON, E.C.

WANTED immediately, a Working MANAGER for a Gas-Works, where the make is about 10 millions. He must be a steady and reliable man, and have a thorough practical knowledge of the Manufacture of Gas and Meters, and taking the Index of same. Age from 30 to 40. House, gas, and coal.

Address, with copies only of testimonials, No. 564, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

WANTED, an experienced Foreman at a Gas-Works, where the consumption of coal is about 900 tons per annum. He must be practically acquainted with the business, and will be required to assist in charging the retorts.

Application to be made to the MANAGER, Gas-Works, TOTNES, stating wages, with testimonials, as well as references to his former employers.

Totnes, July 25, 1879.

TO Gas Managers.—If you want Good Heats, try R. Andrews's Principle of Retort-Setting. Estimates given for Building new Benches.

114, Elsley Road West, Shaftesbury Park, LONDON, S.W.

EXHAUSTER FOR SALE.

FOR SALE, an Engine and Exhauster combined, to pass 7000 feet per hour, together with Boiler, 12 ft. by 4 ft., Boiler Fittings, Connections, Regulator, and Stone Bed.

For particulars, apply to W. T. TEW, Gas-Works, WARWICK.

FOR SALE.—A First-class Tar Factory, with Benzole Refinery attached; the whole erected within the past three years, and in the best possible condition. Doing a business of 3000 to 4000 tons per annum. The factory is situated on its own wharf in a first-class harbour. Satisfactory reasons for disposal.

Principals or solicitors only in first case, apply by letter addressed No. 563, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

FOR SALE.—A Beale's Patent Gas Exhauster, registered to pass 10,000 feet per hour. Worked about two years.

Apply to SECRETARY, Gas Company, LOUTH.

GAS-WORKS (Freehold) for Sale, near London. Price £2500. A dividend of 11 per cent. guaranteed on this amount. Or they may be let on long lease, with option of purchase.

For further particulars, address M. N., 117, Chancery Lane, LONDON, E.C.

TO BE SOLD, Cheap, Three Telescopic GASHOLDERS, two 60 ft. diameter and 20 ft. deep each lift, and one 70 ft. in diameter and 20 ft. deep. Only been in use eight years. May now be seen at work at the Effingham Street Gas-Works, Sheffield.

For price, apply to THOMAS PIGGOTT AND CO., Spring Hill, BIRMINGHAM.

SECOND-HAND Gas Plant Wanted, in Good Condition.

Two Purifiers, 6 ft. by 6 ft. by 3 ft. or 3 ft. 6 in. Scrubber, 7 to 8 ft. high, about 4 ft. in diameter. Condenser, 10 or 12 pipes, 7 or 8 in. in diameter.

Address J. SMEDLEY, Lea Mills, near DERBY.

GAS PLANT FOR SALE.

A 10-in. Vertical Pipe Condenser, having 20 Pipes, each 19 ft. high, on Cast-Iron Base Box.

A Scrubber, 16 ft. high 5½ ft. diameter, fitted with thin boards, Self-Acting Liquor Distributor, 10-in. inlet and outlet pipes.

Two Single-Flue Cornish Boilers (new in 1870), each 9½ ft. long, 3 ft. 9 in. diameter; Fire Tube of Low Moor Iron, complete with all Fittings.

All in good working order; removed to make room for larger plant.

For further particulars apply to THOS. TREWHITT, Gas-Works, WEST HARTLEPOOL.

May 8, 1879.

TO be Sold Cheap, a small Gasholder about 8 ft. in diameter, with three Columns. Apply to JOHN CHAPMAN, Harrow, MIDDLESEX.

TANKS.—Several stout square wrought-iron TANKS, from 2000 to 3000 gallons, suitable for Tar, Anthracine, Oil, &c., are for sale cheap. Also an Air-Pump, with Engine, suitable for Exhausting Gases, &c. Address No. 562, care of Mr. King, 11, Bolt Court, Fleet Street, LONDON, E.C.

GAS APPARATUS FOR SALE.

THE Bury St. Edmund's Gas Company have FOR SALE One Circular STATION-METER with 8-in. Connections; to pass 8000 cubic feet per hour.

One 9-in. GOVERNOR, with water, ballast, and air-chamber.

Connections and valves complete for the above.

Further particulars may be learned on application to JOHN M'CRAE.

Gas-Works, Bury St. Edmund's.

DARWEN CORPORATION GAS-WORKS.

TO COLLIERY PROPRIETORS—TENDERS FOR GAS COALS.

THE Gas Committee of the above Corporation invite TENDERS for the Supply of from 7000 to 8000 Tons of Best GAS COALS per year for One, Two, or Three years, commencing about the 1st of November next.

Specifications and forms of tender may be obtained from the undersigned; but tenders, endorsed "Tender for Gas Coal," to be delivered to C. Costeker, Esq., Town Clerk, Darwen, on or before Monday, Aug. 11, 1879.

By order,
THOS. DUXBURY, Manager.

Gas-Works, Darwen.

WIGAN GAS-WORKS.

THE Gas Committee of the Corporation are prepared to receive TENDERS for the Supply of 40,000 Tons of Best GAS COAL, delivered at the Gas-Works in such quantities as may be required by the Manager during the Two years from Oct. 1, 1879, to Oct. 1, 1881.

The Committee expect to have a railway siding into the Gas-Works in a short time.

Tenders to be addressed and delivered to the Town Clerk, Wigan, endorsed "Tender for Coal," on or before the 5th of August next, at Twelve o'clock at noon.

Tenders not endorsed will be rejected.

The Committee do not bind themselves to accept the lowest or any tender.

MASKELL WM. PEACE, Town Clerk.

July 23, 1879.

ORMSKIRK GASLIGHT COMPANY.

TO BUILDERS AND CONTRACTORS.

THE Directors are prepared to receive TENDERS for the Erection of Brick PURIFYING-HOUSE (with wrought-iron roof), METER-HOUSE, PURIFIERS, &c., together or separately.

Plans, &c., can be seen on application to Mr. Martin, at the Works, Aughton Street, Ormskirk.

Sealed and endorsed tenders to be sent to me not later than the 6th of August next.

The Directors do not bind themselves to accept the lowest or any tender.

WM. PARR, Secretary to the Company.

2, Railway Road, Ormskirk, July 17, 1879.

THE Gloucester Gas Company, ceasing to manufacture gas at their old works, will have the undermentioned APPARATUS for Sale about the beginning of August, viz.:—

110 Mouthpieces, D-shape, 13 in. by 22 in., with Wrought-Iron Lids, Cross-Bars, Stand, Bridge, and Dip Pipes. Also about 150 feet of D-shape Wrought-Iron Hydraulic Main, size 19 in. by 19 in. 28 Mouthpieces, D-shape, 16 in. by 20 in., with Wrought-Iron Lids, Cross-Bars, Stand, Bridge, and Dip Pipes. Also about 38 ft. of D-shaped Wrought-Iron Hydraulic Main, size 20 in. by 20 in. Annular Condenser, consisting of six Vertical Pipes, 24 in. diameter, 19 ft. high, with three 12 in. Slide-Valves and 12 in. Connections.

Scrubber (round), 5 ft. by 20 ft., with three 12-in. Slide-Valves, and 12 in. Connections.

Exhauster (Jones) to pass about 15,000 feet per hour.

Exhauster (Beales) to pass about 25,000 feet per hour.

Two Vertical Steam-Engines, each about 6-horse power, with Pulleys, and Shafting used for driving the above.

Boiler 14 ft. 6 in. by 3 ft. 6 in., with Centre Tube, and four Galloway Patent Tubes.

4-horse power Horizontal Steam-Engine.

Three 4-in. Pumps, with cranked Shafting and a pair Mitre Wheels.

Set of four Purifiers, 12 ft. by 12 ft. by 4 ft., with 12-in. Centre-Valve (Cockeys), and Connections and Lift complete.

Station-Meter by A. Wright and Co., London, with three 12-in. Slide-Valves, and 12-in. Bye-Pass and Connections, to pass about 25,000 feet per hour.

Gasholder, Double Lift, with Cast-Iron Tank, capacity 37,000 feet.

Gasholder, Double Lift, capacity 100,000 feet.

Gasholder, Double Lift, capacity 240,000 feet.

Two 12-in. Governors, by Wright, London, with 12-in. Valves, Bye-Pass, and Connections.

Two 12-in. four-way faced Valves, by Cockey.

For further information, &c., apply to the undersigned.

R. MORLAND, Engineer.

TO INVENTORS AND PATENTEES.

MR. W. H. BENNETT, having had considerable experience in matters connected with Gas, Water, and Sanitary Improvement, begs to say that he continues to assist Inventors in the perfection of their designs, and to obtain for them PROVISIONAL PROTECTION, whereby their invention may be secured for Six Months; or LETTERS PATENT, which are granted for Fourteen Years.

Patents completed, or proceeded with at any stage, thereby rendering it unnecessary for persons resident in the country to visit London.

Patents procured for Foreign Countries.

Information as to cost, &c., supplied gratuitously upon application to the Advertiser, 23, Great George Street, WESTMINSTER.

TOWN of LLANTRISSANT, GLAMORGANSHIRE.

VALUABLE GAS-WORKS FOR SALE.

MESSRS. Stephenson, Alexander, & Co. are instructed to sell by Auction, by order of the Mortgagees, in One Lot, at the Royal Hotel, in the town of Cardiff, in the county of Glamorgan, on Aug. 19, 1879, at Two o'clock precisely in the afternoon, the following valuable and well-constructed Freehold and Leasehold Gas-Works, the property of the Llantrissant Gaslight and Coke Company, Limited, viz.:—

All that piece of Freehold Land containing an area of 1622 Square Yards or thereabouts, together with the Gas-Works and Manager's Dwelling-House erected thereon, and all the Plant, consisting of Gasholder, Retorts, Purifiers, Condenser, Scrubber, Governor, Steam-Boiler, Exhauster, Mains, and other Machinery usually employed in the Manufacture and Supply of Gas. Also all that piece of Leasehold Land containing an area of half an acre or thereabouts, together with the Gas-Works, Cottage, and similar Machinery to the above. Also Pillars and Brackets with Lamps for Lighting Public Streets, and a large quantity of Meters and several thousand yards of Mains. Also about 198 Yards of 3-in. Cast-Iron Pipe in 9 ft. lengths, stowed at the Works.

The leasehold premises are held for a term of 99 years from Aug. 2, 1875, under a lease granted by Vaughan Hanning Vaughan Lee, Esq., M.P., at the yearly rent of £20.

The freehold and leasehold Works are connected, and gas can be supplied to the whole of the district of supply from both or one of them.

The freehold Gas-Works have been in operation for upwards of 12 years, and the leasehold portion was recently added to meet the increased requirements of the district.

The town of Llantrissant is situated within the South Wales mineral basin, and is 12 miles distant from Cardiff.

The works have been supplied with superior gas coal from neighbouring collieries at moderate prices, and gas is supplied to the stations of the Llantrissant and Taff Vale Junction Railway, and to the station, offices, and signals of the Great Western Railway at Llantrissant, besides a large tin-works and waggon works and the houses in the town of Llantrissant, and the villages in the immediate neighbourhood thereof.

Further particulars, plans, and conditions of sale can be had of Messrs. SPICKETT AND PRICE, Solicitors, Pontypridd, GLAMORGANSHIRE.

TO MAKERS OF SULPHATE OF AMMONIA AND BUYERS OR SELLERS OF GAS LIQUOR.

F. SUTTON & CO., Norwich, are now prepared to Supply a Set of Apparatus with Standard Test Solutions for the rapid and accurate analysis of Gas Liquor, which can be used by any intelligent workman, so as to show the actual amount of Sulphate which can be got out of any sample of liquor in a few minutes, without any of the annoyance arising from saturation with acid, &c. Tables are also given, showing the quantity of acid of various strengths required for any given liquor, the accurate ounce-strength and percentage of pure ammonia, &c. Price of the set, with full direction and table (copyright), with materials sufficient for fifty analyses, £4 4s.

Post orders or cheques to be made payable to F. SUTTON AND CO., Manufacturing Chemists, NORWICH, who also supply every description of Standard Solutions for Volumetric Analysis of Waters, Beers, Manures, &c., of guaranteed accuracy.

AMMONIACAL LIQUOR.

THE Directors of the Wakefield Gaslight Company are prepared to receive TENDERS for the Purchase of the AMMONIACAL LIQUOR produced at their Works during the period of One year, commencing Sept. 1, 1879. Estimated quantity, 2200 tons.

Sealed and endorsed tenders to be sent in not later than Saturday, the 16th of August next.

Any further information may be had from the undersigned.

By order,
JOHN W. WHITAKER, Manager and Secretary.

Gas Office, July 14, 1879.

SWANWICK CANNEL.

Illuminating power, 24 candles. Good Coke, 11¼ cwt. to the ton.

For analysis, prices, and references, apply to

H. BOAM, Litchurch Villa, DERBY.

Price 28s., handsomely bound in Morocco, cloth sides, gilt edged and lettered.

THE FIRST VOLUME
OF
KING'S TREATISE
On the Science and Practice of the Manufacture and Distribution of
COAL GAS.

Edited by THOS. NEWBIGGING, C.E., M.Inst.C.E., and W. T. FEWTRELL, F.C.S.

Orders received by
WALTER KING, 11, Bolt Court, Fleet Street, London, E.C.

Prices, half bound, cloth sides, 2 quires, 30s.; 3 quires, 36s.; other sizes and bindings to order.

THE
GAS COMPANIES EXPENDITURE JOURNAL,

Being a Ruled Account-Book with Printed Headings, and Analyzing Guide for Keeping, upon the easiest and most correct method, the Expenditure of a Gas Company, in accordance with the provisions of the Gas-Works Clauses Act of 1871, and suitable for all Companies.

Specimen, with illustration and full particulars; 2s. 6d. returned on the purchase of a "Journal."

Published by SANDELL AND SON, Accountants, 2, Great George Street, WESTMINSTER, and W. KING, Office of the JOURNAL OF GAS LIGHTING, 11, Bolt Court, FLEET STREET, E.C.

M. DAVIS & CO., 27, Wellclose Square, LONDON, E.,
COMMERCIAL GLASS WORKS.

BEST OPAL SHEET GLASS, IN CASES OF 200 FEET.

150 Y	7d. per foot.	26 Y	11d. per foot.
21 Y	9d. ,,	32 Y	1s. 3d. ,,

Enamelled Sheet Glass, Flint and Opal, 1s. 2d. Coloured Glass and Opal, 1s. 6d. to 2s. 6d. per foot.

GAS GLASSES OF ALL DESCRIPTIONS ON HAND; SPECIAL PRICES FOR QUANTITIES.

Now ready, Second Edition, price 7s., by post 7s. 3d., the

GAS MANAGER'S HANDBOOK.

By THOMAS NEWBIGGING, M.I.C.E.

Orders to be sent to

WALTER KING,
11, BOLT COURT, FLEET STREET, LONDON, E.C.

Now ready, price 10s. 6d.,

AN ANALYSIS OF THE

METROPOLITAN GAS COMPANIES ACCOUNTS

For the Year 1878,

(In continuation of the previous Eight Years, 1869—1877,)

COMPILED AND ARRANGED BY JOHN FIELD,

FOR MANY YEARS ACCOUNTANT TO THE LATE IMPERIAL GAS COMPANY.

Can be had of W. KING, Office of "Journal of Gas Lighting," 11, BOLT COURT, LONDON, E.C.;
AND OF
EDEN FISHER & CO., Stationers, 50, LOMBARD STREET, LONDON, E.C.

J. & H. ROBUS,

BUILDERS AND CONTRACTORS

FOR THE ERECTION AND REBUILDING OF GAS AND WATER WORKS,

RETORT-SETTING—A SPÉCIALITÉ.

ROBUS'S IMPROVED RETORT-SETTINGS, guaranteed to Carbonize a large amount of Coal with a small per cent. of Fuel.

ESTIMATES GIVEN FOR MAIN-LAYING.

N.B.—All kinds of Fire Goods and Gas Apparatus supplied on the shortest notice.

Address:—J. & H. ROBUS, BELL GREEN, CATFORD, LONDON, S.E.

THE

THAMES BANK IRON COMPANY,

OLD BARGE WHARF, UPPER GROUND STREET, LONDON, S.E.,

SUPPLY FROM STOCK

CAST-IRON RETORTS AND ALL KINDS OF GAS-WORKS APPARATUS,

SOCKET-PIPES FOR GAS OR WATER PURPOSES,

FLANGE-PIPES FOR STEAM,

RAIN-WATER PIPES AND GUTTERS,

HOT-WATER BOILERS, PIPES, AND CONNECTIONS,

LAMP-COLUMNS, LAMPS, LAMP-FRAMES, WROUGHT TUBES, &c.,

HOT WATER AND HOT AIR APPARATUS,

Erected complete on the most Improved Principles.

GAS *v.* ELECTRIC LIGHT.

WIGHAM'S PATENT GAS-BURNERS

FOR

STREET LIGHTING, &c., WHICH REQUIRE NO GLASS CHIMNEY.

Speaking of these burners, erected on the Thames Embankment by Westminster Bridge, the *Daily News* says:

"... A blaze of light is thrown out, which, in point of efficiency and brilliancy, far surpasses the large gas-lamps lately erected in Waterloo Place, *while even the electric lights are quite thrown into the shade.*"

SOLE MANUFACTURERS:

J. EDMUNDSON & CO., GAS ENGINEERS,

19, GREAT GEORGE STREET, WESTMINSTER, LONDON, S.W.

TRADE MARK.

"LEATHER" "VICTORIA" BELTING

"VICTORIA,"

The Cheapest and Best

LEATHER BELTING

IN LONDON.

The Leather is of the Best Possible Quality, and English Oak Tanned.

Sample Orders of over £5, Carriage Paid to nearest Railway Station.

Is Manufactured expressly for

J. C. R. OKES,

39, QUEEN VICTORIA STREET, LONDON, E.C.,

And can only be obtained from him or his Agents.

PRICES ON APPLICATION.

TO GAS COMPANIES.

GEORGE McKAIG,

MANUFACTURER OF

GAS-PURIFYING WOOD SIEVES,

153, CLEVELAND STREET,

DONCASTER.

It requires but one trial to prove the Superior Make, Strength, and Durability of these Sieves.

CARRIAGE PAID.

E. & W. H. HALEY,

IRONFOUNDERS & MAKERS OF

CAST-IRON PIPES

FOR

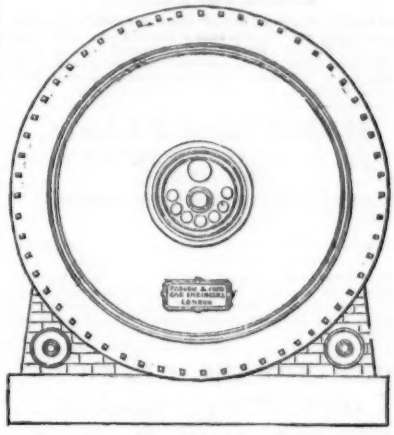
GAS, WATER, & STEAM.

LISTER HILLS FOUNDRY,

BRADFORD, YORKSHIRE.

STATION METERS,

With or without Cast-Iron Stands,



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IMPERIAL METER CO.,

LIMITED,

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KING'S ROAD, ST. PANCRAS,

Manufacturers also of

THE IMPROVED DRY METERS,

CONSUMERS Patent Compensating WET METERS,

Special Meters for Public Lighting, and of

GOVERNORS,

ETC., ETC.

ECONOMY IN THE PRODUCTION OF GAS, AND CARBON DEPOSIT ENTIRELY PREVENTED.

PLUTONIC CEMENT,

FOR JOINTING AND REPAIRING RETORTS AND OVENS *in* ACTION AND *out* OF ACTION.

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WILLIAM RICHARDSON, Gas and Hydraulic Engineer, CHARLES HENRY STREET, and BISSELL STREET, BIRMINGHAM.

Now Ready, Price One Guinea,

PRECEDENTS IN PRIVATE BILL LEGISLATION

AFFECTING GAS AND WATER UNDERTAKINGS.

COMPILED BY MR. G. W. STEVENSON, C.E., F.G.S.

This Work contains information with regard to the practice of Parliament during the last fourteen years, in regard to most of the points on which differences arise in Opposed Bills for Gas and Water Undertakings, comprising—Authorized share and loan capital, Rates of dividend, Capitalization of profits, Term for the repayment of loans, Instances in which new shares are to be sold by auction and Exceptions to the Standing Order requiring new shares to be sold by auction, The limitation of back dividends, Illuminating power, Purity, Price, Notice before testing, The conditions under which the public supply of gas is regulated, Alteration of mains, Instances in which maps of mains are required, and All cases in which undertakings have been transferred, since 1845 in gas and 1865 in water, from Companies to Local Authorities.

In the Water Precedents will be found, in addition, The rates for a supply for domestic purposes, and the Rates for other than domestic purposes.

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WANTED, by Samuel Thompson & Co., Colliery Office, Lancaster, APPLICATION for PRICES from Gas Managers who are prepared to receive Tenders for GAS COAL or CANNEL.

John Leigh, Esq., M.R.C.S., F.C.S., &c., &c., in his analytical report of S. T. & Co.'s Coal, says: "It is remarkable for its purity, I have scarcely ever examined a Coal containing so small a quantity of ash, and when Cannel of the best description is scarce, it may well replace this material."

HENRY LYON (14 years Engineer and Manager of the largest of the Manchester Corporation Gas-Works) Mechanical and Consulting Gas Engineer, reports upon the condition and value of Gas-Works, supplies plans and specifications of all Apparatus appertaining to Gas-Works, and re-models existing Works.

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Public Accountant,

MOORGATE STREET CHAMBERS,

GREAT SWAN ALLEY,

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Mr. ROBERT DEMPSTER,

CONSULTING GAS ENGINEER,

ELLAND, near HALIFAX,

May be consulted on all matters connected with Valuations, Arbitrations, and Parliamentary Applications connected with Gas-Works. Having been engaged on extensive Arbitration Cases, which, combined with his experience in Construction and Contracting, his knowledge of Engineering and Valuations is both extensive and reliable.

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The Forms of Account, which have been specially designed by Mr. Lass to meet the requirements of the Gas-Works Clauses Amendment Act, 1871, are now in use by many Gas Companies, Corporations, and Local Boards.

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Mr. ROMANS has for upwards of 30 years been practically engaged in the Manufacture of Gas, and has, by extensive experiments, ascertained that by JUDICIOUS INTERMIXTURE of the lighter with the heavier gases, much of the rich Hydrocarbons CAN BE SAVED, which otherwise ARE LOST, during the process of manufacture. He is therefore enabled to give advice to those who favour him with their orders for Cannel, as to the class which will secure for their standard of illuminating power the HIGHEST ADVANTAGEOUS RESULTS.

ANALYSIS AND PRICES FORWARDED ON APPLICATION.

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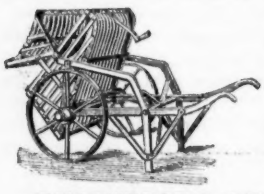

Is acknowledged to be the best in the market; made out of Sheet or Flat Bar Iron.

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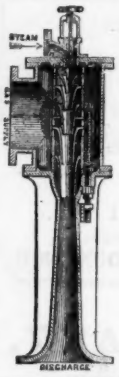

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IMPROVED CLELAND'S PATENT.

UPWARDS OF 300 IN USE.

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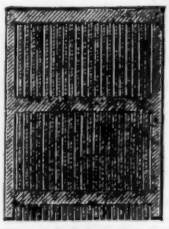

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SCRUBBERS FILLED WITH BOARDS,

On our approved principle, for the extraction of Ammonia.

Prices on application. References to First-Class Engineers.

ROSE MOUNT IRON-WORKS,

ELLAND, NEAR HALIFAX.

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WET & DRY CONSUMERS GAS-METERS,

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BRADDOCK'S PATENT COMPENSATING GAS-GOVERNORS;

ALSO LICENSEES AND MANUFACTURERS OF

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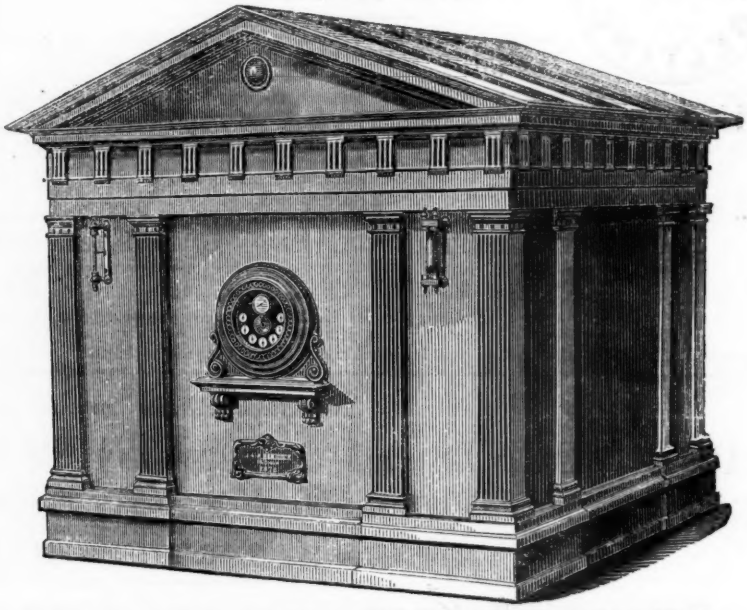


SQUARE STATION-METERS,

WITH PLANED JOINTS.

GOVERNORS, GAUGES, INDICATORS, MAIN COCKS, &c.

GAS COOKING APPARATUS.

Home and Foreign Orders promptly attended to.

All Sizes of CONSUMERS METERS, STATION-METERS, and GOVERNORS generally in Stock.

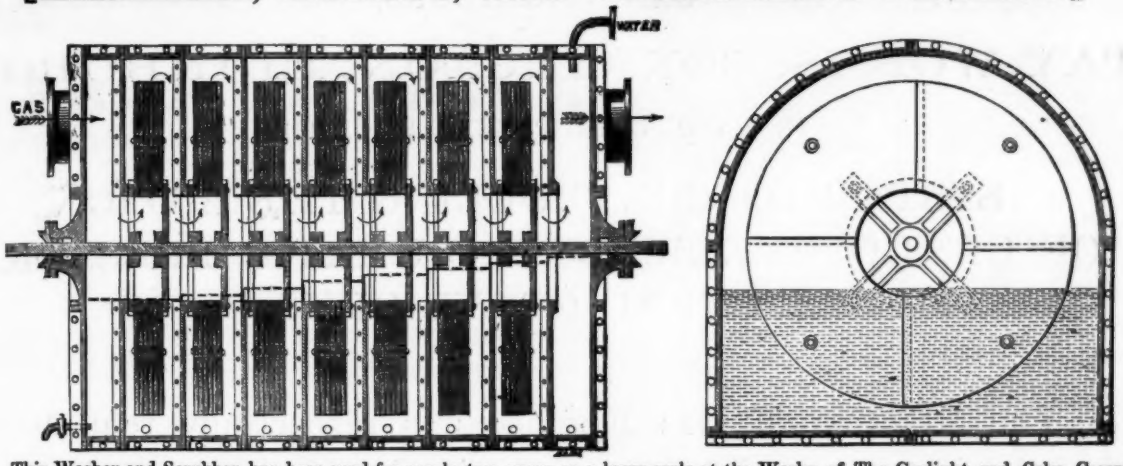
Orders almost invariably despatched on the day of receipt.

TERMS, &c., ON APPLICATION.

THE

"STANDARD" WASHER & SCRUBBER.

[KIRKHAM, HULETT, AND CHANDLER'S PATENT.]



This Washer and Scrubber has been used for nearly two years on a large scale at the Works of The Gaslight and Coke Company, Bromley-by-Bow, at which station there are now several in operation and in course of construction. There is also one in use at the Pancras Station, King's Cross, of the same Company, which is purifying 1,500,000 cubic feet of gas per day. At the Gas-Works of the Corporation of Leeds, a large one has been erected, which is giving complete satisfaction. The Special Merits of this Washer are as follows:—

That it is a very effective Condenser, so that it is not absolutely necessary to reduce the temperature of the gas to 60°, or thereabouts, to make the Washer effective. That the distribution of the liquor is made with unerring regularity. That it occupies very small space, so that it can be, at little expense, effectually protected from extreme changes of the weather. That the considerable expense of Coke or Wood, or other Scrubbing Material, is entirely saved, and that the great nuisance and cost of from time to time replacing the Scrubbing Material is avoided. That, by the revolution of the discs, the quantity of water carried up by them, and tending continuously to fall, exposes a very large amount of fresh wetted surface to contact with the gas. That it is particularly adapted for Gas-Works where Sulphate of Ammonia is manufactured. That it is much cheaper than any other Scrubber that will do the same amount of work effectually. That it is the only Washer suitable for purifying Gas from all its impurities by solution. That it works with a minimum of pressure. That it takes out every trace of Ammonia from the Gas in once traversing the machine. That it requires very little outlay for foundations.

The following Testimonials show the opinion of eminent Engineers as to the capabilities of the Washer:—

D. HULETT, Esq. *The Gaslight and Coke Company, Bromley-by-Bow, May 3, 1877.*

Dear Sir,—In answer to your inquiries respecting the results of the working of your Patent Washer, I beg to state that I find it a very efficient machine. I have had it in operation for some time, and passed gas through it continuously at the rate of 100,000 cubic feet per hour, and obtained from it 11 gallons of 10 oz. liquor per ton of coal carbonized—results which appear to me very satisfactory for so small a Washer. It works very smoothly, taking but little power, and giving no pressure. I have it still in operation, and am perfectly satisfied with its working.

I am, dear Sir, yours truly, (Signed) W. B. WRIGHT.

Messrs. KIRKHAM, HULETT, and CHANDLER. *The Leeds Corporation Gas-Works, York Street, Leeds, Dec. 6, 1878.*

Gentlemen,—The Scrubber-Washer erected by you at these works, and which has been in use for six months, has proved to be, so far as we have been able to test it, thoroughly efficient. We are at present making 32,000 feet of gas per hour, and are entirely dependent on this apparatus for the removal of Ammonia, and the **Gas is perfectly free from that impurity in the sixth chamber**, so that four chambers remain to deal with an increasing make of gas. Owing to insufficient condensers, the gas was in the summer admitted to the Scrubber at a temperature of 70°, but was reduced therein to 61°, or that of the atmosphere. The volutes are driven at the rate of four revolutions per minute, and, working at that speed, there is not the slightest difference between the inlet and the outlet pressure. Clean water supplied at the rate of 10 gallons per ton of coal carbonized is converted into liquor of from 10 oz. to 13 oz. strength **in once traversing the vessel.** The apparatus is extremely simple and compact, occupies but little space, and requires no foundation. I shall be surprised if it does not eventually become extremely popular.

I am, Gentlemen, yours faithfully, (Signed) HENRY WOODALL, Engineer.

Messrs. KIRKHAM, HULETT, and CHANDLER. *The Gaslight and Coke Company, York Road, King's Cross, Jan. 14, 1879.*

Gentlemen,—In reply to your inquiry, I am pleased to say, the Washer which was put in action at this station in October last has quite fulfilled my expectations, as it confirms the experiments I made in May last with the smaller machine. Working at four revolutions per minute, **it takes out every particle of Ammonia**, while purifying more Gas than it was intended to do. I enclose particulars of a fortnight's working during our heaviest make, by which you will see that it yields the full quantity and strength of liquor, and works with little pressure. I am therefore quite satisfied with the machine, and trust it may meet with the success it deserves.—I remain, &c. (Signed) JOHN CLARK.

The following Table shows the results of the working of one of these Washers, lately erected to purify 60,000 feet of Gas per Hour, at the St. Pancras Station of The Gaslight and Coke Company:—

1879.	Nos. of the Divisions and Strength of Liquor in each.										Water used per Ton of Coals.	Gas Purified per Hour, Cubic Feet.	Ammonia on Outlet.	Temperature.			Pressures.		Revolutions per Minute.
	1	2	3	4	5	6	7	8	9	10				Inlet.	Outlet.	Atmosphere.	Inlet, Inches.	Outlet, Inches.	
	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.									
January 1	8¼	6¾	5	3½	2¼	1½	1	½	0	0	10 Gallons.	52,000	Nil.	77°	73°	48°	24	23	7½
,, 2	8¾	7	6	4½	3¼	2⅛	1½	¾	⅛	0	10 ,,	57,000	Nil.	78°	66°	32°	21½	20½	4
,, 3	9¼	8	6	3⅝	3	2⅛	1½	¾	⅛	0	10 ,,	60,000	Nil.	75°	68°	40°	23½	22	4
,, 4	9¼	7¾	6¼	4¼	3¼	2¼	1⅛	¾	⅛	0	10 ,,	65,000	Nil.	74°	68°	33°	24	22½	5
,, 5	9½	7	6	4	3	2⅛	1¼	¾	⅛	0	10 ,,	34,000	Nil.	77°	68°	35°	14½	14	5
,, 6	9¼	7½	6½	4½	3	2¼	1½	1	¼	0	10 ,,	63,000	Nil.	72°	66°	27°	24	23½	4½
,, 7	11	9	7	5½	3¾	3	1⅝	1½	⅜	0	10 ,,	59,000	Nil.	74°	66°	31°	25	23½	5
,, 8	9½	7½	6	4½	3	2	1	¾	¼	0	10 ,,	78,000	Nil.	73°	61°	31°	28	26½	4½
,, 9	11	9	7	5	3⅜	2½	1½	1	⅜	0	10 ,,	82,000	Nil.	74°	67°	33°	27½	25½	5
,, 10	10⅜	8½	6¾	5	3½	2⅜	1½	1	⅜	0	10 ,,	66,000	Nil.	76°	64°	28°	28½	27	5
,, 11	12½	10	7⅞	5⅞	4	3⅛	1⅞	1¼	½	0	10 ,,	61,000	Nil.	73°	64°	27°	28½	25½	5
,, 12	11	8¾	6¾	—	—	—	1¼	¾	¼	0	10 ,,	39,000	Nil.	74°	64°	27°	26½	25½	5
,, 13	13	10½	8¼	6	4¼	3¼	2	1⅛	½	0	10 ,,	78,000	Nil.	73°	65°	42°	28	26	5

Messrs. KIRKHAM, HULETT, and CHANDLER. *Corporation of Birmingham, Gas Department, Saltley Works, May 23, 1879.*

Gentlemen,—I beg to enclose you a copy of the results of the tests which, by the kind permission of the Engineer, Mr. Clark, I made on the 6th of March last, of the working of one of your "Standard" Washers and Scrubbers at the St. Pancras Station of The Gaslight and Coke Company, and I am of opinion that, for an apparatus occupying so small a space, they are exceedingly satisfactory.—Yours truly, HENRY HACK, Engineer.

Working Results obtained from KIRKHAM, HULETT, *and* CHANDLER'S *Patent "Standard" Washer and Scrubber at the St. Pancras Station of The Gaslight and Coke Company, London, March 6, 1879.*

Gas passing per Hour, Cubic Feet.	—	Impurities in Gas per 100 Cubic Feet.			Temperature.		Pressure in Inches.	Revolution of Apparatus per Minute.	—	No. of Divisions and Strength of Liquor.										Water Used during Experiment. Gallons.
		SH_2	CO_2.	Grains. NH_3.	Washer.	Air.				—	—	—	—	—	—	—	—	—	—	
64,000 {	Inlet	2·00	2·00	158·8	72	57	21	4½	Twaddel deg. at 60°	5·3	4·9	2·85	2·35	1·7	1·05	0·6	0·3	0·18	0·1	63
	Outlet	1·50	1·50	0·8	68	57	20		Acid, ounces. . .	11·0	8·4	6·3	4·5	2·7	1·7	1·3	0·7	0·3	—	

WASHER-SCRUBBERS OF THIS PATENT ARE IN COURSE OF CONSTRUCTION FOR BECKTON, BRADFORD, GREENWICH, WOOLWICH, AND SEVERAL OTHER GAS-WORKS.

For further particulars and testimonials, address

Messrs. KIRKHAM & HERSEY, GAS ENGINEERS, 21, ABINGDON STREET, WESTMINSTER.

D. BRUCE PEEBLES & CO.,

GAS ENGINEERS,

TAY WORKS, BONNINGTON, EDINBURGH,

INVENTORS AND PATENTEES OF THE

SYSTEM OF CONTROLLING THE ACTION OF GAS-GOVERNORS BY PNEUMATIC PRESSURE INSTEAD OF WEIGHTS.

The attention of Gas Engineers is respectfully requested to the following recent Improvements in Instruments employed for controlling Pressure from Gasholder to Burner:—

FIRST.—Patent Safety Station-Governor, most delicate in its action and free from pulsation. It may be controlled directly by weights, or at any distance by the Pneumatic system. It does not occupy above a third of the space required for ordinary Governors.

SECOND.—Patent Dry Metallic District Governor for reducing pressure in elevated districts. This is a differential Governor which responds to the requirements of the district, and also to the increase or diminution of pressure at the Station-Governor. A self-acting Syphon is attached, so that the Governor, after being fixed and adjusted, requires no attention whatever.

THIRD.—Patent Metallic Needle Governor for Public Lamps, with adjusting screw for regulating the consumption. This Governor is made of incorrodible materials; many thousands of them are now in use, and giving every satisfaction.

FOURTH.—Patent Metallic Needle Governor Burner, which gives a steady flame irrespective of the increase of pressure in the mains. It completely obviates hissing and roaring, and brings out the full illuminating power of coal or cannel gas.

This is the only self-acting Burner made of a size suitable for ordinary use. It is not rated like the lamp-governor, but is adjusted so that at pressures varying from about 8 to 30-10ths and upwards in the mains, a steady flame is ensured. It should be used with a globe having wide openings.

Whenever there is any unreasonable complaint by customers as to the quality of the gas, Managers should put in these burners.

N.B.—All the above Instruments, having been practically tested, are recommended with perfect confidence.

D. B. P. & CO. ALSO MANUFACTURE

WET AND DRY GAS-METERS OF THE BEST QUALITY, STATION-METERS, AND CLOCK LAMP-PILLARS FOR THE NEW AVERAGE SYSTEM OF STREET LIGHTING.

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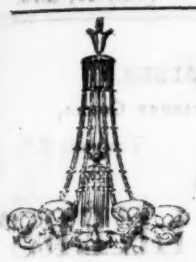
TAY WORKS, BONNINGTON, EDINBURGH.



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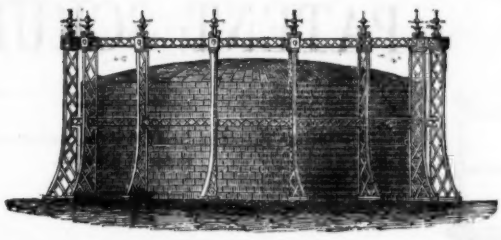
CHANDELIERS IN BRONZE AND ORMOLU. MODERATOR LAMPS.



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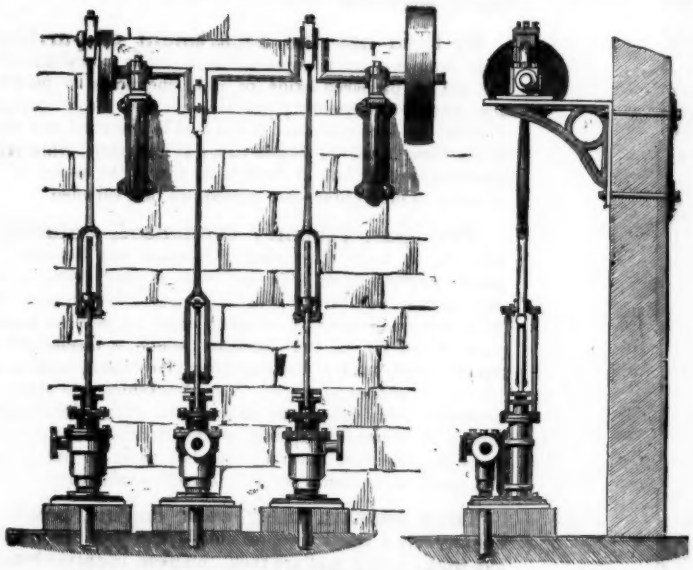

IMPROVED DOUBLE-ACTION PUMPS.

For Water. For Tar. For Ammoniacal Liquor.

This illustration shows an arrangement of three (No. 179) Improved Double-Action Pumps driven from the same crank-shaft, as frequently supplied for use in Gas and Chemical Works. The suction and discharge pipes can be arranged for drawing from and delivering in any required direction

These Pumps have been supplied to nearly all the large Gas Companies and Chemical Works, both for Pumping Water, Tar, and Ammoniacal Liquor.

GAS SYPHON PUMPS, IN COPPER OR SHEET IRON, ALWAYS IN STOCK.

Illustrated Catalogues sent post free on application.

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Manufactory for every description of Casting and Machinery for Gas-Works and Water-Works.

Warehouse in London for Cast-Iron Pipes and Connexions of all sizes and in any quantity, Scott's Wharf, Bankside, Southwark.

Agent in London, Mr. J. MANWARING, 101 Cannon Street, E.C.

JAMES OAKES & CO.,

ALFRETON IRON-WORKS, DERBYSHIRE,

AND

WENLOCK IRON WHARF, 21 & 22, WHARF ROAD, CITY ROAD, LONDON, N.,

Manufacture and keep in stock at their works (also a large stock in London) PIPES and CONNECTIONS 1½ to 48 inches in diameter; and make to order Retorts, Purifiers, and Tanks, with or without planed joints, Columns, Girders, Special Castings, required by Gas, Water, Railway, Telegraph, Chemical, Colliery, and other Companies.

NOTE.—Syphons and Covers are joint-faced if required, doing away with millboard and iron boring, or Syphons made without Covers, a socket being cast on and fitted with a small plug about 6 inches in diameter with lead joint. In either way preventing leakage.

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SILICA FIRE-BRICK CO.,

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Near SHEFFIELD,

Manufacturers of THE ORIGINAL SILICA OR DINAS FIRE-BRICKS. Specially adapted for Gas-Retort Furnaces and for Siemens's Gas-Furnaces. Shipments promptly executed to London, Liverpool, Hull, Grimsby, &c.

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FIRE CLAY & BRICK WORKS,

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Manufacturers of GAS-RETORTS, GLASS-HOUSE FURNACE & BLAST-FURNACE BRICKS LUMPS, TILES, and every description of FIRE-BRICK.

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Manufacturers of all Descriptions of

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Of all Dimensions for Gas-Works,

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ESTABLISHED 1836.

The Highest Award was obtained by H. & M., at the Philadelphia Exhibition, 1876, for Superior Quality of Manufacture. SILVER MEDAL, PARIS, 1878.

GAS AND WATER PIPES.

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CAST-IRON GAS AND WATER PIPES.

DELIVERY F.O.B., GLASGOW.

Prices on application.

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MANN & WALKERS' PATENT SCRUBBER.

By Letters Patent in Great Britain, Europe, and the United States of America.

By some important improvements recently patented, the purifying power of these Scrubbers has been much increased, and a stronger ammoniacal solution obtained, which is found to absorb a large portion of the carbonic acid contained in gas, effecting an important saving in money and labour in the lime purifiers, and where oxide only is used, the increase in the illuminating power of the gas obtained by these Scrubbers is shown in a remarkable degree, in consequence of the large quantity of carbonic acid removed from the gas.

It is to be particularly noted that the important results of these Scrubbers do not depend upon the machinery alone. The entire internal construction of the Scrubber bears an almost equally important part. For this reason, where it is desirable to convert existing Scrubbers, whose dimensions happen to be suitable, the work commences by ripping out the whole of the interior of the shell, and beginning the internal construction *de novo* from bottom to top.

Fifty million cubic feet of gas per 24 hours are purified from ammonia by these Patent Scrubbers in a winter's day in the gas-works of London, where the purity of gas supply is the highest in the world, under the chemical restrictions of the Board of Trade.

Generally, wherever a high standard of purification is maintained in the chief cities and towns of the British Provinces and of Europe, these Scrubbers have become established.

By their use the department of purification from ammonia upon a gas-works is made complete, without the aid of prepared oxide of iron, chemicals in purifiers, or any other supplementary process, and the whole ammoniacal residual product contained in the coal is absorbed and obtained in the form most profitable to a gas company, while the requirements of all Acts of Parliament and of the Board of Trade, relating to incorporate gas companies, are satisfied.

Foul Gas, properly condensed, entering the inlet is, by once only passing through the Scrubber, completely purified from ammonia with regular certainty day by day, without any further trouble, or any other process, effected by a very small quantity of clear water let into the machinery room at the top of the Scrubber, which is discharged at the liquor outlet at the bottom, from Newcastle coal at about 18 to 20 ounces strength, from Yorkshire and other coals generally from 25 to 30 ounces strength; while acidulated litmus or turmeric exposed at the Scrubber outlet will not show the slightest discoloration, and there is not a quarter of a grain of ammonia per 100 feet left unabsorbed.

They contain their own engine power, requiring only a small inappreciable quantity of steam from the gas-works boiler, and are then complete in themselves, ready for service.

Applications relating to dimensions and prices should be addressed to us, C. AND W. WALKER, 8, FINSBURY CIRCUS, LONDON, E.C., or to Mr. WILLIAM MANN, late Superintendent of the Chartered Gas-Works, BLACKFRIARS, LONDON; they should state approximately the largest make of gas in 24 hours on a winter's day, and the smallest make on a summer's day, to be purified.

WILLIAM SUGG'S
IMPROVED SYSTEM OF STREET LIGHTING,
SUITABLE FOR EITHER COMMON OR CANNEL GAS.

Results obtained in Illuminating Power from WILLIAM SUGG'S 200-candle Burners with Cannel and Common Gas.

Burner used.	Variety of Gas.	Cubic feet of Gas burnt per hour.	Illuminating Power in Sperm Candles burning 120 grains per hour.	Number of Candles to which every cubic foot of Gas burnt is equivalent.
Sugg Burner	Common 16-candle ..	53·4	228	4·25
Do.	Cannel 19-candle ..	47·3	252	4·76

Joint experiment by—

CHARLES HEISCH, Superintending Gas Examiner to the Corporation of London.

T. N. KIRKHAM, M.I.C.E., F.C.S.

C. MEYMOTT TIDY, M.A., M.B., Professor of Chemistry and of Forensic Medicine at the London Hospital, Medical Officer of Health for Islington, and late Deputy Medical Officer of Health for the City of London.

The Illuminating power of the gas made by this Company, on the 9th inst., was 22·7 standard sperm candles for a consumption of 5 cubic feet per hour, in a Sugg's No. 7 steatite bat's-wing burner. On the same day the following results were obtained from two of Sugg's large new Argand Burners:—

FIRST EXPERIMENT.

Burner: Sugg's Argand, with two concentric flames.

Consumption per hour . . . . . 22·2 cubic feet.
Illuminating power . . . . . 103·7 candles.
or 4·67 candles per foot of gas.

SECOND EXPERIMENT.

Burner: Sugg's Argand, with three concentric flames.

Consumption per hour . . . . . 40·8 cubic feet.
Illuminating power . . . . . 208·8 candles.
or 5·12 candles per foot of gas.

I have reason to believe that these are as high, if not the highest results yet obtained per foot of gas from these burners.

(Signed) WILLIAM KING,
Liverpool United Gaslight Company,
Engineer's Office, Duke Street.

Liverpool, April 16, 1879.

[See JOURNAL OF GAS LIGHTING, April 22, 1879.]

"Sugg's 200-candle burner, with 42·09 cubic feet of 20·85-candle gas, gave an illuminating power of **231·56** candles."

"Same quality of gas as used at Westminster Bridge, and Waterloo Place, Regent Street."

(Signed) A. C. M'MINN,
Engineer to The Gaslight and Coke Company,
Kensal Green Station.

June 16, 1879.

SUGG'S ARGAND WITH THREE CONCENTRIC RINGS.

Illuminating Power of Gas.	Standard of Comparison.	Gas Consumed per Hour. Cubic Feet.	Illuminating Power.	Illuminating Power per Cubic Foot.
21 Candles	5-ft. London Burner..	45	220·5	4·9
		43	210·0	4·88

(Signed) J. R. FRITH,
Engineer, Runcorn Gas Company.

Glasgow Herald, April 25, 1879—

"The light exhibited last night" (Sugg's 200-candle Burner and Lantern) "was equal to 360 Candles—more than double that given by the old lamps, while the consumption of gas was exactly the same,—40 cubic feet per hour."

Major Dresser, Editor of the *American Gaslight Journal*, writes that—

"With 30 cubic feet of cannel gas I obtained 196·4 candles."

NOTICE.—Notwithstanding a number of statements which have been repeated in the public journals, that burners by other makers have surpassed these results, the reports of comparative experiments from which the above extracts have been copied conclusively prove that **the "Sugg" Burners give over 30 per cent. of Illuminating Power more than can be obtained from any other burners with the like quantity of gas.**

PRICES AND PARTICULARS ON APPLICATION TO

WILLIAM SUGG,
GAS ENGINEER,
VINCENT WORKS, WESTMINSTER, S.W.

ROBERT MARSHALL,

CANNEL COAL MERCHANT,

198, ST. VINCENT STREET, GLASGOW.

SHOTT'S BOGHEAD.

HARTHILL CANNEL

Yields 14,920 cubic feet of 40·92-candle gas per ton.

THRASHBUSH CANNEL

12,530 cubic feet of 40·22-candle gas per ton, and 9 cwts. of good coke.

LOTHIAN'S CANNEL

Yields 12,500 cubic feet of 34-candle gas per ton, and 9 cwts. of excellent coke, containing only 4 per cent. of ash.

MUIRKIRK, No. 1, CANNEL

Yields 12,160 cubic feet of 32·5-candle gas per ton, and 10 cwts. of excellent coke, containing only 5 per cent. of ash. This cannel is almost free from sulphur.

OLD WEMYSS CANNEL

Yields 13,320 cubic feet of 32·5-candle gas per ton.

Prices and full analyses on application at above address, or from WEDDERSPOON, FERGUSSON AND Co., 21, Lime Street, LONDON, E.C.

GAS COAL.

THE MIRFIELD COAL COMPANY are supplying GAS COAL of the best quality on trucks at their siding. This Coal contains 10 per cent. of Cannel, and, as analyzed by Mr. James Paterson, of Warrington, yields 12,600 *cubic feet of* 16·67 *candle gas, with* 1430 *lbs. of good Coke, per ton.* Ash in Coke, 1·88.

Apply to the MIRFIELD COLLIERY, Mirfield, NORMANTON. London Agents: SMITH BROS., 38, THROGMORTON ST., E.C.

HEBBURN MAIN GAS COAL.

This Coal is now highly approved of for gas making, and yields over 10,000 feet per ton of 15-candle gas, and about 14 cwt. coke.

For references and prices, either f. o. b. or by rail, apply to

W. RICHARDSON,

29, QUAYSIDE, NEWCASTLE-ON-TYNE.

GAS COAL.

THE Tawd Vale Colliery Company, Limited, are prepared to Contract for the Supply of their superior Arley and other GAS COALS, and to send samples to the order of Gas Engineers and others, or complete analysis on application. Shipped at Liverpool, Preston, Fleetwood, Garston, or Birkenhead.

Mr. James Paterson, C.E., F.G.S., in his analysis of T. V. Arley Coal, says: "Some parts merge into a semi-Cannel; Gas per ton, 10,300 cubic feet; illuminating power, 16·96 candles; coke of high quality, 1431 lbs. per ton."

Collieries, Skelmersdale, near Ormskirk; Offices, 5, New Hall, Old Hall Street, LIVERPOOL.

GAS COAL.

POPE & PEARSON, LIMITED, have now the authority of several of the most eminent Gas Engineers of London in stating that their Coal yields *in practical working over* 10,000 *cubic feet of gas, with an illuminating power of* 16 *candles;* or by the standard burners now used by the London Gas Companies, an illuminating power equal to 17½ candles.

One ton yields 12½ cwt. of good coke. This Coal can be shipped from Hull, Goole, Liverpool, Morecambe, and Barrow.

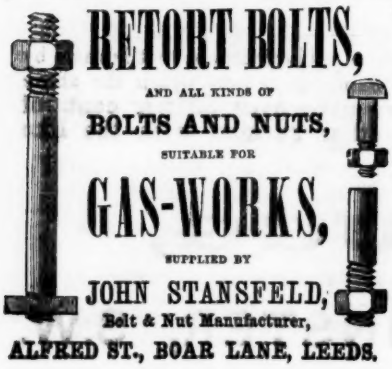
For further particulars, apply to POPE AND PEARSON, LIMITED, West Riding and Silkstone Collieries, near LEEDS.

M. BREMOND'S NAPHTHALINE PROCESS.

A negotiations respecting M. Brémond's patented process for preventing Deposits of

NAPHTHALINE

in Gas Main and Service Pipes should be addressed to Mr. W. H. BENNETT, 22, Great George Street, WESTMINSTER, S.W., or to M. BREMOND, Gas Engineer, Compania Madrilena de Alumbrado y Calefaccion por Gas, MADRID, who may be consulted upon all matters connected with the Gas Industry.



RETORT BOLTS,

AND ALL KINDS OF

BOLTS AND NUTS,

SUITABLE FOR

GAS-WORKS,

SUPPLIED BY

JOHN STANSFELD,

Bolt & Nut Manufacturer,

ALFRED ST., BOAR LANE, LEEDS.

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AGENT FOR

THOMAS BARR'S LESMAHAGOW MAIN CANNEL,

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NEWTON, CHAMBERS, & CO.'S SILKSTONE GAS COALS.

Analyses and Quotations on application.

WILSON CARTER AND PEARSON,

GAS COAL AND CANNEL FACTORS,

Supply to any Railway Station or for Export all kinds of Fuel for Gas purposes.

Address—CHIEF OFFICES:

TEMPLE BUILDINGS, 50, NEW STREET, BIRMINGHAM.

GEORGE ANDERSON,

GAS AND CONSULTING ENGINEER,

35A, GREAT GEORGE STREET,

WESTMINSTER, S.W.,

PATENTEE and MANUFACTURER of the following Inventions:—

RETORT SETTINGS—giving great Economy of Fuel.

STEAM-ENGINES and EXHAUSTERS, FOUR-WAY VALVES, WASHERS, SCRUBBERS.

FUEL-MACHINE, for Compressing Breeze and Tar.

N.B.—Pamphlet, with Eighteen Illustrations and Letterpress on the Construction of Gas-Works, post free, 2s. 6d.

PRICES AND ALL PARTICULARS TO BE HAD OF THE PATENTEE,

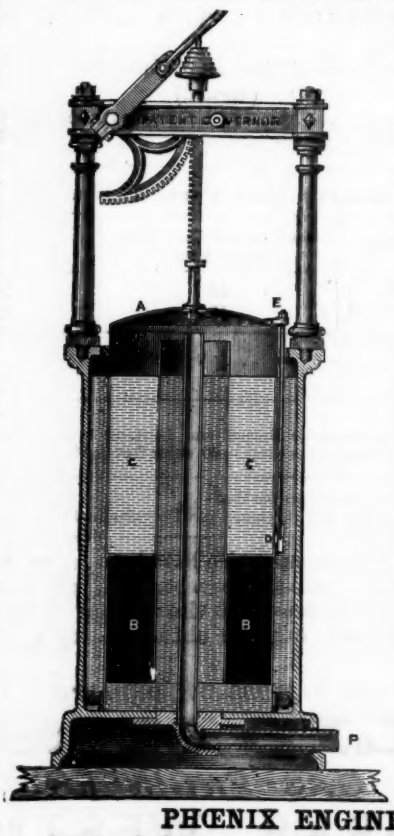
35a, GREAT GEORGE STREET, WESTMINSTER, S.W.

GEORGE WALLER & CO.,

GAS AND HYDRAULIC ENGINEERS,

Patent Compensating Steam Governor,

WITH SELF-CONTAINED WATER-BALANCE.



DESCRIPTION OF THE APPARATUS.

The illustration represents a section of the Patent Governor. The lower part of the Bell A is fitted with a loose Float B, and in the upper part of the Bell is a deep annular Water Chamber C, at the bottom of which is an opening D, with a slide outside regulated by a Screw Spindle E, to allow the water to pass in and out of the Chamber C quickly or slowly, according to circumstances, but when once adjusted the slide does **not require altering.** This Self-compensating Chamber gives great steadiness to the up and down movement of the Bell and effectively prevents the "hunting" motion so common with other Governors, thereby ensuring a more perfect action on the throttle-valve of the Engine **than attained by any other.** The sketch shows the clip lever fixed to work on throttle-valve at an angle, and can work in either direction. P is the Gas Inlet-pipe to Governor.

G. W. & Co. also make **special Steam Throttle Valves,** suitable for working with this Governor, and alter existing Throttle Valves to same plan.

PHŒNIX ENGINEERING WORKS,

Holland Street and Bear Gardens, Southwark, S.E.

THE SILKSTONE & DODWORTH COAL & IRON COMPANY, LIMITED,

DODWORTH, BARNSLEY.

BENJAMIN WHITWORTH, Esq., M.P. . . . . Chairman.
Mr. RICHARD HARTLEY . . . . . Managing Director.

REAL OLD SILKSTONE GAS COAL.

JAMES PATERSON Esq., Gas Engineer, of the Warrington Gas Company, reported, Aug. 10, 1875:—
"This Coal possesses remarkable qualities as a gas and coking coal, and appears SECOND TO NONE IN THE KINGDOM. It contains the large quantity of 699 lbs. of illuminating matter, and 1498 lbs. of coke to the ton, and produces **12,240** cubic feet of 16·66 candle gas."

The above Company are raising nearly a thousand tons of the Real Old Silkstone Gas Coal per working day.

PRICES QUOTED TO ANY RAILWAY STATION, OR F.O.B. HULL, GRIMSBY, GOOLE, KEADBY, LIVERPOOL, AND FLEETWOOD.

GAS COAL. GAS COAL. GAS COAL.

WELLS, BIRCH, RYDE, and CO., Limited,

HOYLAND SILKSTONE COLLIERIES,

Near BARNSLEY.

This Company is now in a position to raise **2000 tons per day of REAL OLD SILKSTONE GAS COAL.**
"The quality of this Coal for Gas purposes, if equalled, is not excelled by any on record, and the Coke competes successfully with best Durham."—See *Mining Journal*, Aug. 11, 1877.
Prices quoted to any Railway Station, or F.O.B. Hull, Grimsby, Goole, Keadby, Liverpool, and Fleetwood.
Full particulars will be sent on application to above address.

ROBT. DEMPSTER & SONS,

GAS ENGINEERS, IRONFOUNDERS, AND CONTRACTORS,

ROSE MOUNT IRON-WORKS, ELLAND, YORKSHIRE.

MANUFACTURERS OF EVERY DESCRIPTION OF

GAS APPARATUS;

CONTRACTORS FOR THE

ERECTION OF PUBLIC AND PRIVATE GAS-WORKS.

Plans and Specifications Prepared, and Illustrated Catalogues forwarded on application.

SULPHATE AMMONIA.

R. W. WALLACE & CO.,

60, MARK LANE, LONDON, E.C.,

Are Buyers of SULPHATE AMMONIA in Large or Small Quantities, or Sell on Commission for Gas Companies and Makers.

PLANT ERECTED ON THE LATEST AND MOST APPROVED PRINCIPLE.

AGENTS to THE GASLIGHT AND COKE COMPANY, LONDON, for the SALE of SULPHATE AMMONIA. Works: BECKTON.

PARIS EXHIBITION, 1878.

THREE MEDALS

AND

HONOURABLE MENTION

HAVE BEEN AWARDED TO

JOSEPH CLIFF & SONS

For their Various Exhibits, amongst which is a

SILVER MEDAL

FOR THEIR

PATENT MACHINE-MADE

RETORTS AND FIRE-BRICKS,

Being the Highest Honour given for this class.

Established

1795.

JOSEPH CLIFF & SONS,

THE ORIGINAL

WORTLEY FIRE-BRICK WORKS,

NEAR LEEDS,

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SPECIAL NOTICE.—Our Patent Machine-Made Retorts have now been thoroughly tested, and have proved themselves infinitely superior to those made by hand. At several large works it has been settled, beyond question, that, owing to the compactness and general excellence, more gas is sent to the gasholder from each ton of coal carbonized than is the case with hand-made Retorts.

CROLL'S
DRY GAS-METERS,

PRIZE MEDALS.
LONDON, 1851;
NEW YORK, 1853
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(INVENTED & PATENTED IN 1844,)

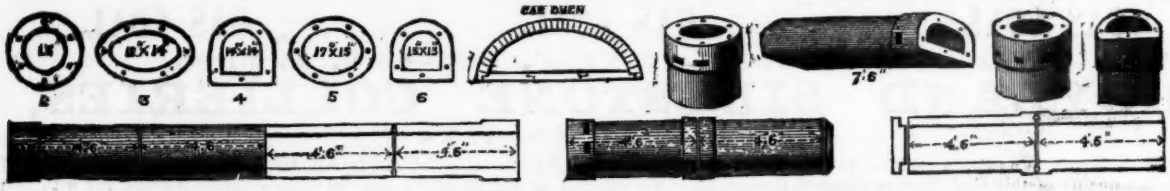
COMBINING ALL THE LATEST IMPROVEMENTS,

MANUFACTURED ONLY BY

PRIZE MEDALS.
LONDON 1862;
DUBLIN, 1865;
PARIS, 1867

THE GAS-METER COMPANY, LIMITED,

238, KINGSLAND ROAD, LONDON, N.E.



HARRIS & PEARSON, STOURBRIDGE,

Proprietors of Best Clay Mines. Largest makers in the World of Gas-Retorts, Lumps, Tiles, Fire-Bricks, and Fire-Clay Goods of all kinds. 200,000 feet of Gas-Retorts of all Sizes and Patterns in Stock, all in good order. Orders for any Size executed on receipt.

CAST-IRON GAS AND WATER PIPES,
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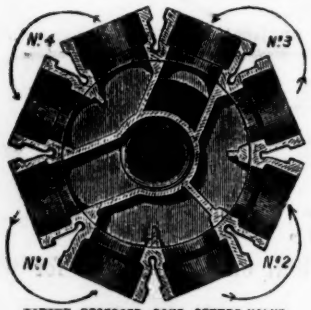
RECESSED CONE CENTRE-VALVES,

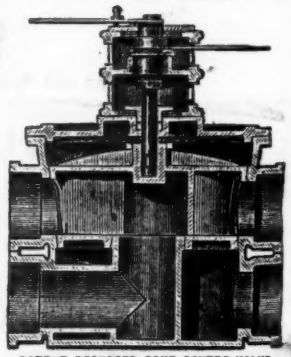
Constructed on the principle of the ordinary Plug-Cock.

THROUGH-WAY & FOUR-WAY COCKS

Of all descriptions.



PATENT RECESSED CONE CENTRE-VALVE.
Sectional Plan.


PATENT RECESSED CONE CENTRE-VALVE.
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London Office: 6, LITTLE BUSH LANE, CANNON STREET.

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Invite the attention of Gas Companies, Corporations, and others to their

PATENT STREET LAMPS,

Which are so constructed that neither putty nor other materials are required to secure the glass. No hacking out of old putty, which frequently destroys the frames. A new pane of glass can be inserted in two or three minutes by any inexperienced person, the glass being secured by a hinged flap and turn button.

PRICE, with Opaline Reflecting Top, 12s.; with Fluted Glass Top, 10s. 6d.
Also made EXTRA STOUT recommended for its durability.

D. HULETT'S IMPROVED SERVICE CLEANSER,

By the use of which stoppages in service and other pipes are freed from naphthaline and other obstructions in a few minutes. PRICE 73s. net.

HULETT'S PATENT MERCURIAL REGULATOR,

For inserting in mains, to prevent the excess of pressure in high ground, or other elevated positions.

PATENTEES OF IMPROVED WET AND DRY GAS-METERS.

Makers of all kinds of Pressure-Gauges, Gaseliers, and every kind of Gas-Fittings for the Trade.

GAS HEATING AND COOKING STOVES.

55 and 56, HIGH HOLBORN, LONDON.

London: Printed by WALTER KING, for the Executors of the late WILLIAM BOUGHTON KING (at the office of Clayton and Co., 17, Bouverie Street, Fleet Street), and published by him at No. 11, Bolt Court, Fleet Street, in the City of London.—Tuesday, July 29, 1879.